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INTRO

EDITORIAL

WHAT'S INSIDE *APC*

EDITORIAL

Building time

Yes we can.

BEN MANSILL
Loves the satisfying click of new memory being installed.

Hi everyone, I hope the cool winter has been tolerable for you. I find myself more than ever in my small gaming room, ironically grateful for once for the heat my OC beast generates as I lose myself in pretend worlds. Also, Hot Hands Toe Warmers. My god, those things. I am addicted.

Anyway. Thought I'd spend a bit of space talking about our Blueprints section. It's one of my favourite parts of the mag, though it's also one of the most time-consuming to put together. Scouring the web for the best deals on components we have in mind, often taking a tangental turn when we discover particularly nice pricing in some segments – or in particular products – takes a while, but the joy of completing yet another hypothetical build is so satisfying.

Each of our three Blueprints builds is hypothetical. It's important to understand that. These aren't PCs we've actually built – though, of course, we could. But that's not the point of these pages. They exist to show you case studies of three sample builds that we feel are an excellent balance of components at that moment in time. We consider their interoperability carefully. Each part fits into the whole. Think of this as a recommendation for a full PC, or just a particular component – these are *APC*'s top picks for what you can buy now.

> "We do hope you get some good use from these pages when it comes to upgrade time."

If you do choose to take that list to a reseller and ask them to build it for you, well, that's a mighty fine compliment for us, and we're glad to have provided some help. But do feel free to swap around brands, or even specs to your needs. Going to a different brand of GPU or memory won't undo the careful planning, and I need to stress that prices and availability does change as time passes.

I had a nice email from an *APC* reader a few weeks ago asking for upgrade suggestions, and as much as I'd like to answer each of these with a personal recommendation, time isn't on my side, so in this case I simply shared the latest Blueprints pages, with a few comments. The next day an email came in from a shop catering to a gent wanting them to build the Intel Budget machine verbatim. The final price was just $60 off, and that was six weeks after we made that particular build list. So not so bad, I reckon! The shop didn't have the motherboard we'd listed in stock, but it was an easy change to another model with the same chipset and features.

We do hope you get some good use from these pages when it comes to upgrade time. For us, here, there's little in life for us geeks that brings more happiness than creating perfect PC builds in a perfect hypothetical situation.

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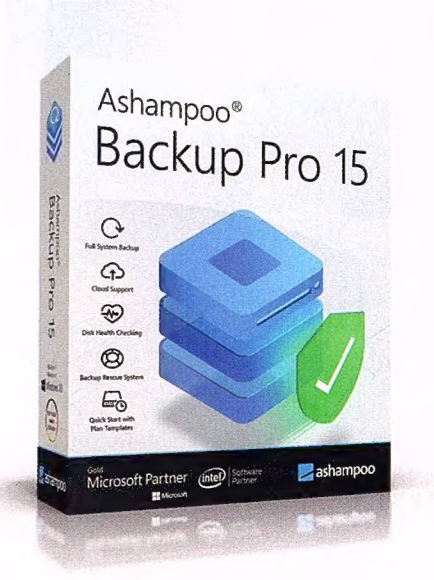

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ASHAMPOO BACKUP PRO 15

Backup solution to create and restore files and entire disk partitions.

Ashampoo Backup Pro 15 is Windows-based a comprehensive backup solution to back up or restore any file, partition or bootable operating system. Archives can easily be restored in the event of hardware issues or system malware infections. Backups can be created fully automatically thanks to smart background technology that does not interfere with normal PC operation. For that, Ashampoo Backup Pro 15 monitors the system load and only becomes active when enough resources are available. Four selectable compression methods and strong encryption ensure space-efficient and secure backup archives.

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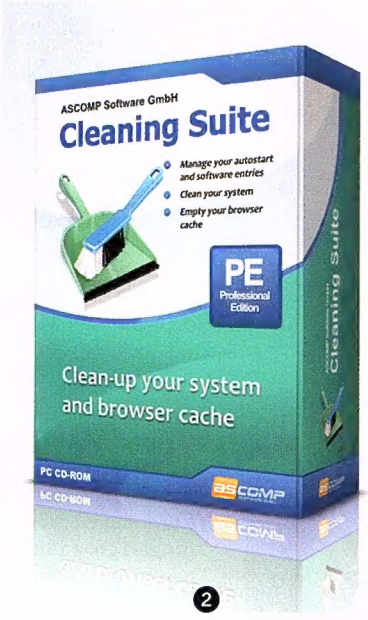

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Misplaced one of those pesky product keys? MyKeyFinder's got you covered!

Where is the license key of Microsoft Office? Or Windows? Or from Adobe Photoshop? MyKeyFinder helps the user to keep serial numbers in orderWhat is the serial number of my Adobe Acrobat? If the user wants to install a licensed program again or on a second computer, the setup requires the license key. It is usually given to the user on the package or on the DVD case of the software. Over the years, these serial numbers are easily lost. What can you do in this case? The solution for this issue: MyKeyFinder: This Windows tool search and list the user license keys, so that they are available every time they are needed.

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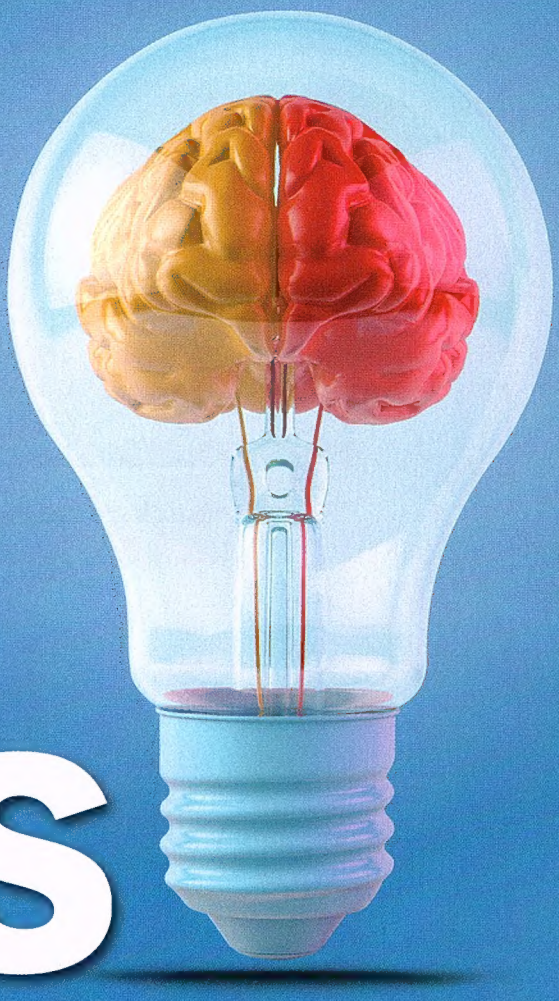

GIVE YOUR PHONE SUPERPOWERS

INSTANT TIME SAVERS FOR PCs AND MACs

TOOLS YOU NEVER KNEW EXISTED

HACK YOUTUBE

YouTube is an endless source of entertainment, but it can also be frustrating, annoying and invasive. Robert Irvine reveals every secret trick to make the video-sharing service work better

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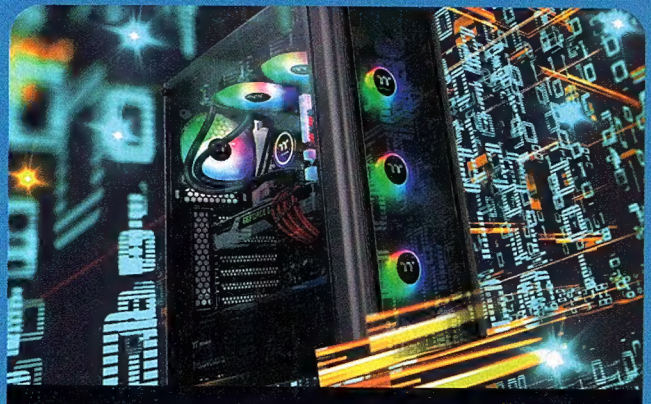

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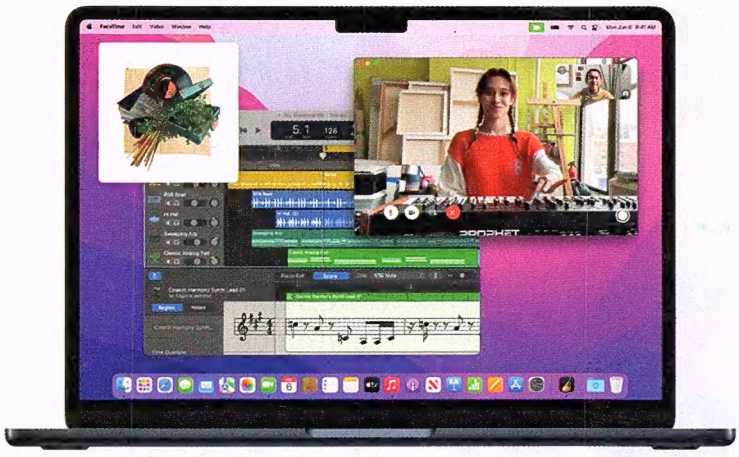

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HOW WE DO IT

Inside *APC*

Find out all about APC's editorial policies, test practices, how to read the benchmark results, and more.

"Championing technology doesn't mean we're unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage."

APC is Australia's oldest consumer technology magazine – having been consistently in print for forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, *APC*'s journalists want to know what's good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred.

apc TESTBED

The current APC testbed used in the Labs for benchmarking all components. This testbed is updated as new and relevant technology comes on stream.

CPU	AMD Ryzen 7 5800X
Motherboard	Asus ROG Crosshair VIII Dark Hero
GPU	Zotac RTX 3080 Ti AMP Extreme Holo
Memory	Crucial Ballistix Sport DDR4-3600 2x16GB
Primary SSD	Adata S70 2TB NVMe
Secondary SSD	Samsung 980 Pro 500GB NVMe
Cooling	Nzxt X73 360mm AIO
Case	Thermaltake Core P8
Power Supply	Corsair AX1000

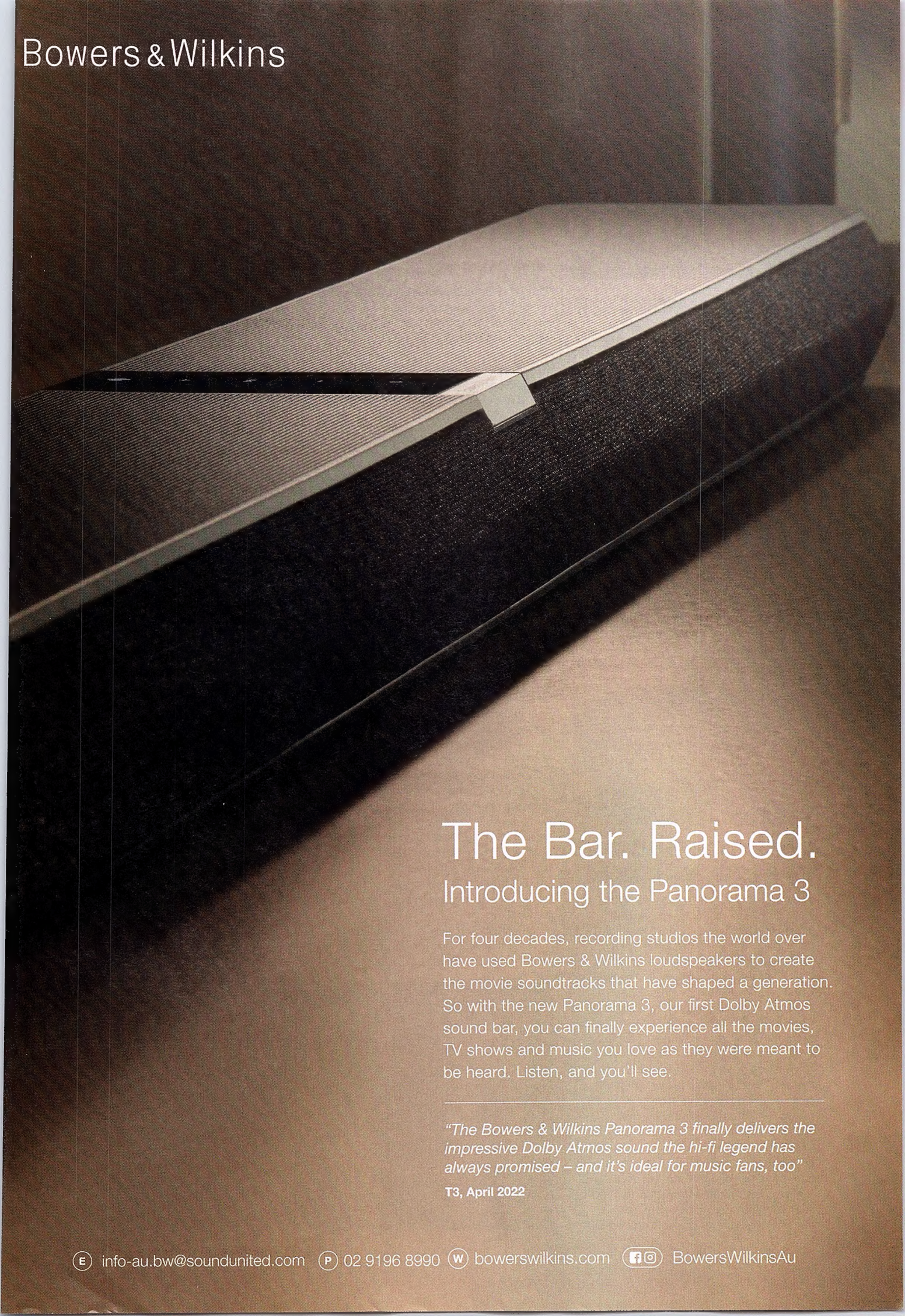
apc AWARDS

APC EDITOR'S CHOICE

When a reviewed product scores 4.5 out of 5 or higher, it carries the Hot Award. These are products that exceed expectations and deliver a quality experience up there with the very best.

APC HIGHLY RECOMMENDED

You will see this award if a reviewed product has scored four out of five stars. It means most people can expect satisfying performance from the product, and that we would use it ourselves.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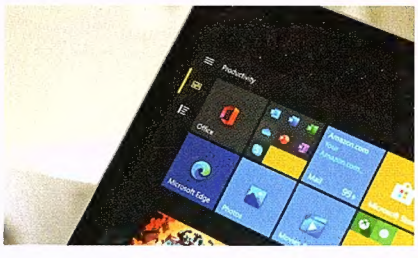
MSI INTRODUCES WORLD'S FIRST ATX 3.0 PSU

Ready for 2,600W power spikes.

MSI has introduced the world's first fully compliant ATX 3.0 power supply: the MEG Ai1300P PCIE5. This unit is designed for power-hungry next-gen GPUs, and can withstand 2,600W power spikes.

ATX 3.0, which was finalised back in February, is Intel's latest power supply standard. The new standard notably supports the brand-new 16-pin 12VHPWR power connector, which allows for up to 600W of power consumption from a single cable. ATX 3.0 also introduces a number of new power specifications, with improved efficiency and reliability ratings and a much higher tolerance for power spikes. MSI says the unit can handle up to double its power, or 2,600W, and is designed to counteract the large power spikes expected on next-gen GPU hardware.



MICROSOFT EDGE REALLY WANTS YOU TO LEAVE GOOGLE CHROME

And it just made it easier to do so.

Microsoft Edge has an update available that brings the browser to version 104. The changes are relatively minor but should make it easier to move over from Google Chrome. Microsoft Edge's First Run Experience now allows users to migrate Chrome data over by logging in to a Google account. With the new feature, people can bring over their Chrome data without having Google Chrome installed on their system. Edge 104 also has a new default security option. Following the update, the browser will apply an added layer of security when viewing less visited sites. "With enhanced security mode, Microsoft Edge helps reduce the risk of an attack by automatically applying more conservative security settings on unfamiliar sites and adapts over time as you continue to browse," explains a Microsoft support doc.

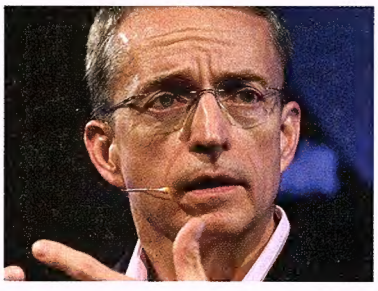
DANGEROUS WATERS

Intel's GPU unit losses estimated at $5 billion

Research firm suggests selling it off.

The head of Jon Peddie Research, a leading graphics market analysis firm that has been around for nearly 40 years, suggests that Intel might axe its Accelerated Computing Systems and Graphics Group (AXG). The division has been bleeding money for years and has failed to deliver a competitive product for any market segment that it serves. Forget the best graphics cards; Intel just needs to ship fully functional GPUs.

Jon Peddie estimates that Intel has invested about $5 billion in its discrete GPU development – investments yet to pay off. In fact, Intel's AXG has officially lost $3 billion since its formal establishment in Q1 2021. Given the track record of Pat Gelsinger, Intel's chief executive who scrapped six businesses since early 2021, JPR suggests that AXG might be next.



"Gelsinger is not afraid to make tough decisions and kill pet projects if they don't produce – even projects he may personally like," Peddie wrote in a blog post. "[...] The rumour mill has been hinting that the party is over and that AXG would be the next group to be jettisoned. That rumour was denied by Koduri."

When Intel disclosed its plans to develop discrete graphics solutions in 2017, it announced plans to address computing, graphics, media, imaging, and machine intelligence capabilities for client and datacenter applications with its GPUs. As an added bonus, the Core and Visual Computing Group was meant to address emerging edge computing market.

Five years into its discrete GPU journey, the company has released two low-end standalone GPUs addressing cheap PCs and some datacenter applications; launched its low-power graphics architecture for integrated GPUs; delivered oneAPI that could be used to program CPUs, GPUs, FPGAs, and other compute units; cancelled its Xe-HP GPU architecture for datacenter GPUs; postponed (multiple times) shipments of its Ponte Vecchio compute GPU for AI and HPC applications (the most recent was partly due to the late arrival of the Intel 4 node), and delayed the launch of an Xe-HPG ACM-G11 gaming GPU by about a year.

Considering how late to market Intel's Arc Alchemist 500 and 700-series GPUs are already and the fact that they will have to compete against AMD's and Nvidia's next-generation Radeon RX 7000 and GeForce RTX 40-series products, it is highly likely that they will fail. This will obviously increase Intel's losses.

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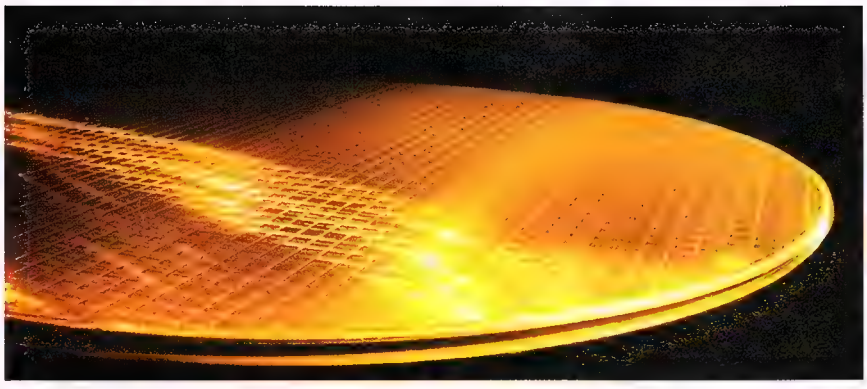

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ALL THE SMALL THINGS

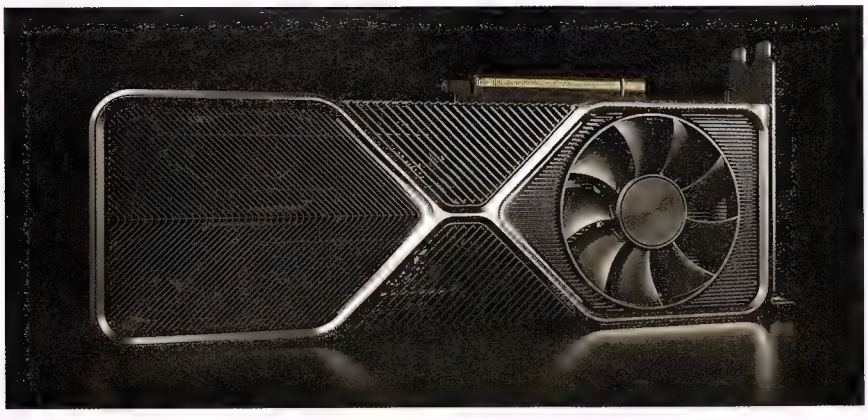
Micron starts bleeding edge 232-layer NAND production

Bigger and faster SSDs are incoming.

Micron announced that it has begun shipping 232-layer TLC NAND. The new NAND will certainly be finding its way into the fastest SSDs on the market, including Micron's Crucial branded SSDs. The new NAND delivers 100 percent higher write bandwidth, more than 75 percent higher read bandwidth, a 50 percent increase in transfer rate and a 28 percent package size reduction.

According to Micron via *Digitimes* this means these cutting-edge NAND dies are smaller, faster and denser than anything else on the market. They are suited for everything from high end consumer SSDs, to mobile and data centre applications.

We can expect this NAND to be used in upcoming PCIe 5.0 SSDs, though not immediately. Western Digital and Samsung will use their own in-house NAND, but future drives with the Phison PS5026-E26 controller will surely include 232-layer NAND. Many of the best PCIe 4.0 drives include Micron 176-layer NAND, including the excellent Seagate Barracuda 530 and Silicon Power XS70 among others. It's only natural to assume that manufacturers will use the best components they can get their hands on.



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NVIDIA REPORTEDLY RESUMING RTX 3080 12GB PRODUCTION

We will probably see 3080 12GB at super cheap prices.

According to a Tweet by insider @Zed__Wang, Nvidia has resurrected the RTX 3080 12GB SKU, in an effort to clear out more GA102 dies from its overstocked inventory. This is a very abrupt change by Nvidia since the 3080 12GB was reportedly dropped from production lines just three months ago. But, we can't blame Nvidia with the "oversupply" crisis going on right now surrounding high-end GPUs.

For those unfamiliar with Nvidia's "stealthy" 3080 model, the 12GB was quietly introduced earlier this year in January at the sole request of AIB partners. The buffed-up memory system makes the 3080 12GB a gaming beast, with the card actually outranking the 3080 Ti on our GPU benchmarks database. Considering that the RTX 3080 12GB could be quite a bit cheaper than the 3080 Ti, this is a great value.

© Bethesda

PROSPECTIVE *STARFIELD* MODDERS ARE ORGANISING EARLY

Fan patch at the ready.

A group of modders is already coalescing to create a *Starfield* Community Patch to address bugs in the game, even though we're still more than half a year out from the highly-anticipated sci-fi RPG's planned release.

There's a rich history of fan fixes for Bethesda games. Alongside flashier mods that add Master Chief to *Skyrim* or a McDonald's to *Morrowind*, projects like the Unofficial *Oblivion* Patch do the thankless, lunch pail work of addressing mesh errors, scripting hiccups, and mismatched item enchantments that withstood official bug fixes. Grabbing the equivalent patch for a given game is usually our first stop after reinstalling an old favourite, especially when it comes to those running on the Gamebryo and Creation engines Bethesda's been building on since *Morrowind*.

BAD NEWS, AMAZON PRIME MEMBERS

One of your best perks is being taken away.

Amazon has revealed it is closing its cloud storage platform in another consolidation push from the tech giant. The company has emailed Amazon Drive customers to confirm that the service will be closing at the end of next year. The move comes as part of Amazon's push towards its Amazon Photos service, which will now become a central location for photo and video storage.

Users will need to download all their files by the closing date, but existing Amazon users will have had their photo and video files automatically saved to Amazon Photos. The service will remain fully operational until December 31, 2023, but the company says that, from January 31, 2023, it will no longer support uploading files on the Amazon Drive website. ■

TECH BRIEF

AMD photonics patent reveals a hybrid future

Looking to accelerate scaling and power efficiency closer to the speed of light.

AMD has been secretly working on photonics technologies. While this is an expected development – photonics is one of the budding technological fields for both classical and quantum computing systems – it does represent a new venue for the company itself.

The information comes from a recently published patent, which AMD originally filed in the United States back in 2020. In this patent, the company describes a system that would allow for photonics-based communications systems to be directly connected to a chip.

Photonics takes advantage of the speed of light, which allows for much faster information transmission rates and increases energy efficiency (because there's no loss to electrical resistance from the usual mediums, such as copper). AMD's work in directly linking beams of light to a die would allow for improvements in latency and power consumption – which, in turn, would improve both performance and scalability.

The patent – like most patents – is fuzzy. It generally describes the manufacturing steps needed to fabricate a chip that can handle photonic-based input and outputs. The manufacturing of such a chip would be necessarily different from those the company manufactures today, and would involve the integration of both a photonic and a silicon chip atop an organic redistribution layer (ORDL).

In current approaches, these layers lack the organic part (the O in RDL), and are usually metal-based interconnects that redistribute the I/O access to different parts of the chip – not unlike TSMC's Through-Silicon-Vias (TSV) technology that allows for 2D and 3D chip integration. So we're seeing an approach that's not unlike the usage of organic materials in OLED televisions and monitors, which in that case are used to emit light according to the electrical frequencies they're exposed to.

A typical SoC (System-on-Chip) is then added on top of this organic layer, enabling it to receive the redistributed light pulses that would ferry information in and out of the chip itself. The SoC computes information and passes it on to the photonic chip – placed alongside it – through the organic layer itself. This photonic chip would then transmit the information over a fibre optic cable to wherever it needs to go. And according to AMD's patent, these three components could all be manufactured on their own wafer substrates – facilitating the fabrication process – while being packaged together afterwards.

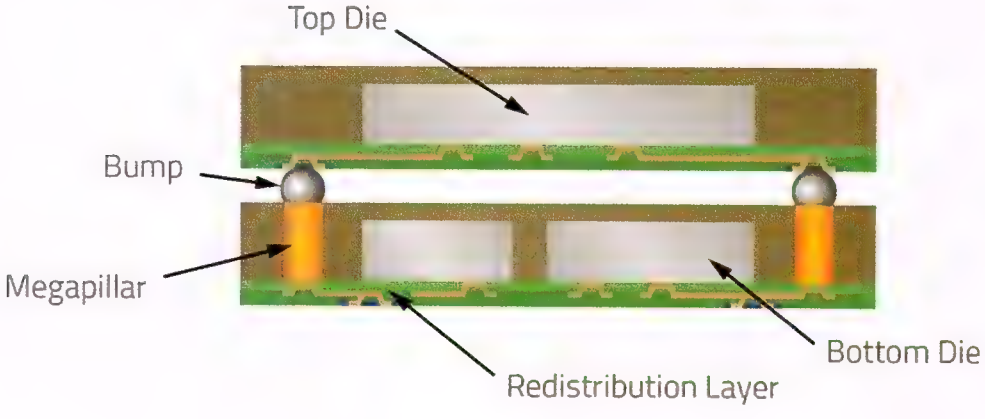
AMD's patent shows that the company is looking for ways to improve scalability that go beyond what conventional semiconductors allow. As the benefits from increasingly denser transistors have declined in recent years, while compute requirements have only gone up, chip designers have had to start looking for more creative ways to improve performance and – crucially – power efficiency.

It's unlikely these technologies will make it into products anytime soon, let alone your next-door PC hardware store. But technology has a way of dropping lower in the cost scale. While initial hybrid applications of photonics and classical SoC may be a few years in the future, such venues of chip design are indispensable for further scaling in High Performance Computing (HPC) environments – where the big bucks are made.

> "Photonics takes advantage of the speed of light, which allows for much faster information transmission rates and increases energy efficiency."

The latter have also been hitting limits on air cooling capability for the increasingly denser, more energy-efficient, but ultimately more power-hungry, chips – and they, too, are looking for outside-the-box ideas to allow increased scaling – ideas such as liquid immersion cooling. Photonics' capability to transmit information without adding heat to these systems – while improving communications' speed and energy efficiency – sounds like a safe bet.

Francisco Pires ■



A slice of a typical semiconductor. Note the metallic redistribution layers.

© Semiengineering

TECH BRIEF

Apple reportedly plans to plaster your iPhone with ads

Get ready for more ads on your iPhone.

Apple plans to bring in more ad revenue in different iPhone and iPad apps by expanding the scope of advertisements seen in the App Store and in Apple Maps, Apple Books, and more, according to a new report.

In his latest Power On newsletter, *Bloomberg*'s Mark Gurman stated Apple will be significantly expanding its advertising business over time. The reliable analyst believes the Cupertino tech giant will bring search ads to Apple Maps, as it's reportedly already been explored. It would allow businesses to pay to be more prominent in search results.

Apple Books and Apple Podcasts could also be getting the advertisement treatment, letting publishers pay to have their work appear more in searches and throughout the app. Using ads throughout apps isn't anything new, as users already see display ads in the Apple News and Stock apps, with the former giving publishers a portion of ad revenue.

Not to mention the App Store. Here, apps for iPhone, iPad, and Mac are promoted if developers pay to have their apps shown more prominently. The question is: if Apple already has advertising spotted around its suite of apps, why does it need to expand? As Gurman notes, its to do with a major revenue hit with all kinds of companies, and Apple wanting to increase its ad revenue to the (billion dollars) double digits.

Last year, Apple introduced App Tracking Transparency, allowing iPhone and iPad to block ad tracking across other companies' apps and websites. It's a privacy feature that lets users opt out of having their data collected by various apps, which has been a hit with users. In fact, Gurman states that 78 percent of iOS 15 users disabled ad personalisation.

However, you can still be tracked in Apple's apps. As the report points out, the app tracking feature "does not follow you across apps and websites owned by other companies," Apple states. Still, ad revenue is a big commitment Apple wants to pursue, and there's be a restructuring of sorts. VP of advertising platforms Todd Teresi is again reporting to Apple Services head Eddy Cue, with Teresi previously reporting to Cue before 2016 when iAd was a thing (a now discontinued mobile advertising platform).

Teresi aims to ramp up ad revenue annually from $5.7 billion to something in the double digits, hence the increase in ads across iPhone and iPad. In an earnings call, CEO Tim Cook still called the state of its ad business "great," but there are a lot of pain points Apple needs to sort out to boost its ad revenue without upsetting customers.

"Using ads throughout apps isn't anything new, as users already see display ads in the Apple News and Stock apps, with the former giving publishers a portion of ad revenue."

The good news is Gurman doesn't anticipate Apple putting ads inside of third-party apps for the time being, but more ads are coming. Is it fair to put ads in apps on an iPhone that could cost close to $2,000?

Darragh Murphy ■

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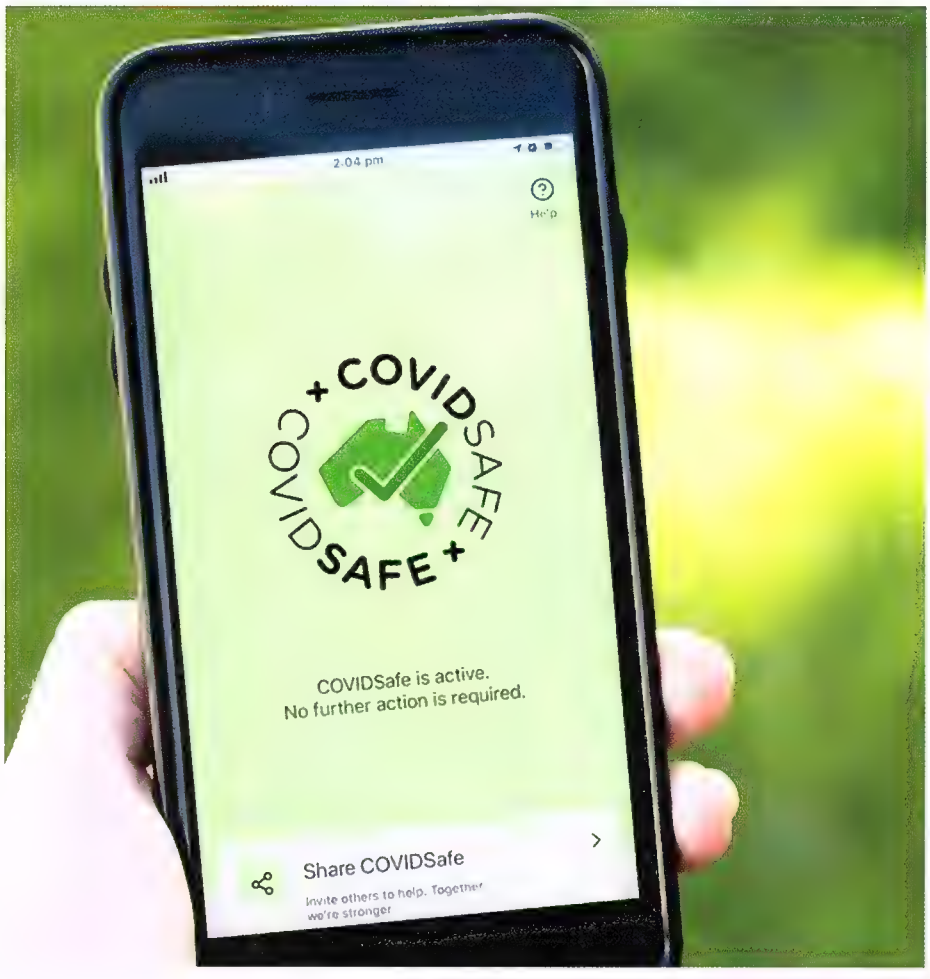
END USER

CovidSafe is dead

The bizarrely shipshod contact tracing app cost taxpayers over $21 million, writes Shaun Prescott.



When the CovidSafe app released at the height of the Covid-19 pandemic in 2020, opinion was split as to whether it was a) an effective way to chart the spread of the virus, and to thus help contain it, or b) a gnarly trojan horse for increased government surveillance. Whichever side of the fence you inhabited – perhaps you just sat on it – one thing is now certain: the whole thing was a giant waste of time and money.

> "Leaving legitimate privacy and surveillance concerns aside, the app wasn't a bad idea: it just wielded some awkward technology not fit for the purpose."

The app, which was downloaded by nearly seven million Australians and chewed through $21 million in taxpayer's money, allowed users to keep track of whether they had been in close proximity with someone diagnosed with Covid-19. If an app user was found positive, any fellow app user who had been near them at the same time would be contacted by health workers. The thing used Bluetooth tech, and was found early on to be fairly ineffective, especially when it came to Bluetooth transmission between certain models of iPhone. That was later reportedly fixed, but that hasn't really improved the final stats: a sum total of 17 close contacts were detected in NSW through the app between its April 2020 launch and the end of 2021. More morbidly amusingly, is that the app only had a hand in detecting two positive cases.

When the Omicron strain hit and state governments mostly opted for a "let it rip" approach, the CovidSafe app wasn't even usefully repurposed. Which it could have been in theory, with possible use cases being QR code check-ins. The Coalition government had clearly given up on the app as early as May 2021, which was when the last bounty of CovidSafe data was uploaded to the app's data store. Never mind, though: the app was still costing around $75,000 a month to operate.

Leaving legitimate privacy and surveillance concerns aside, the app wasn't a bad idea: it just wielded some awkward technology not fit for the purpose. Early on, iPhone users needed to have the app open and their phone unlocked for the functionality to operate, which, well, that's just not how people use smartphones. The Labor government clearly relished the opportunity to declare the app a disaster, but it didn't have to be. Not on every level, at least.

The use of Bluetooth led to some amusing though obvious problems, too. According to a Lancet Public Health study summarised on The Conversation, a "close contact" could have been someone in a neighbouring flat of an apartment building, or someone in a nearby restaurant, or even "people waiting in separate cars at Covid drive-through testing clinics".

It's naturally pretty difficult to think things through at the beginning of a deadly pandemic. But traditional contact tracing was a far more efficacious tool than this botched and expensive app. The government claimed that contact data stored on a device would be "automatically deleted after 21 days" and that it is not accessed by the government official unless the user consents.

And hey, here's progress: according to Labor Health Minister Mark Butler, of the 7.9 million registration "fewer than 800 users" consented to sharing this information. ■

© The Conversation

The best laptop CPU of 2022

The devices are in and scores calculated, so which CPU should you be looking to buy in your 2022 laptop?

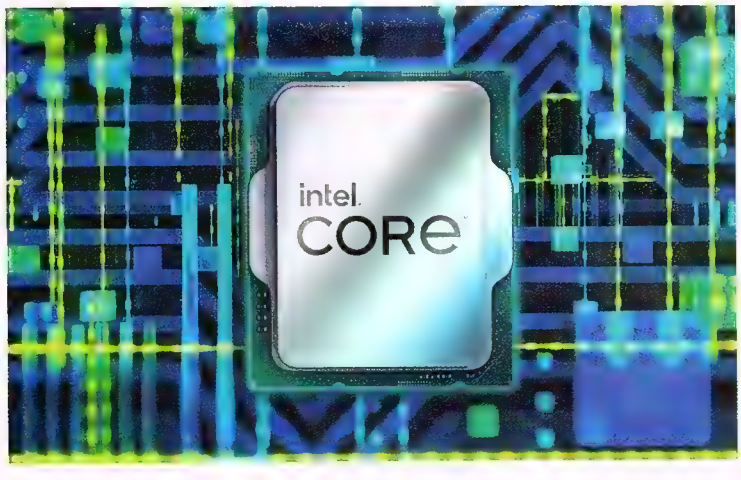
While we've had 12th generation Intel based laptops trickling in since March, this month we got our hands on the first AMD Ryzen 6000 series laptop processor in the Asus ROG Zephyrus G14 (p35). We also just covered Apple's 2022 MacBook Air running the company's updated M2 processor on page 34. With all the major 2022 laptop processors now on the table we can finally take a look at them side-by-side to see what each of them do well and which one you may want in your next laptop.

Gaming and workstation laptop CPUs

In the gaming and workstation spaces we've had a chance to look at Intel's i9-12900H and i7-12700H CPUs which both have 14 cores, 20 threads and have a 45W Thermal Design Power (TDP). Against this is Apple's 10-core M1 Pro drawing around 31W and the 10-core M1 Max pulling more like 35W. From AMD we have just the one eight core 16 thread Ryzen 9 6900HS with a TDP of 35W.

In Geekbench 5 multi-core CPU benchmarks both the Apple processors actually outperformed the higher watt Intel processors, on average, with a combined score of 12,617, compared to 11,980 for the i9 CPU and 11,169 for the i7. All of these scores were notably higher than the 9,757 that the Ryzen 9 6900HS could muster. It's worth pointing out that there was quite a bit of variability on the intel chips across devices and one model (the MSI Raider GE76) both the i9 and i7 Intel CPU managed to score over 13,000 in this test, so while we would say Apple came out ahead in this test, Intel's 12th generation is potentially more powerful when given adequate thermal management.

When it came to the Cinebench R23 benchmark, the i9-12900H took the crown with a multi-core average of 15,546. Next up was the Intel Core i7-12700H with an average score of 13,576. Interestingly, the top Intel Core i7-12700H performance was over 70 percent better than the lowest performing i7-12700H device. This means that we had i7 units well outperforming i9 processors while others performing worse than what we would expect from an i5. Landing, just behind the i7 average were the Apple M1 Pro and M1 Max processors netting 12,525 and 12,709 respectively. Followed again by AMD which managed just 11,729.



Ultrabook CPUs

At the time of writing we hadn't tested an ultrabook running one of AMD's 6000 U series processors that operate within 15-28W, so it's just Intel's i7-1260P CPU against Apple's M2 processor here. The i7-1260P has 12 cores and 16 threads, with a 28W TDP while Apple's eight or 10-core CPU has a 20 Watt TDP.

In Geekbench 5 multi-core benchmarks the two Intel i7-1260P laptops averaged 8,997.5, with the M2 processor sneaking in just behind with a score of 8896. In Cinebench R23 however a MacBook Air running the M2 processor scored 8,481 in the multi-core CPU benchmark, beating both Intel based devices average of 8,104.5.

Verdict: *While Intel's i9-12900H takes out the best overall performance in 2022, Apple's processors compete and often beat anything from Intel and AMD with significantly lower power draws.* ■ **Joel Burgess**

TWO BITS

Winamp returns from the dead

Not that it ever really went away.

Winamp, perhaps the best MP3 player ever, is back in active development. In fact, it's one of my all-time favorite PC apps. It was synonymous with the MP3 revolution and it was omnipresent on all of my systems for well over ten years.

Before the days of music streaming, the MP3 reigned supreme. In the late 1990's, Winamp became an essential tool as users discovered the convenience of MP3s. Who could forget those days in late 1999 when you could search Napster and find music from every genre? All of the songs I downloaded were played in Winamp. Afterwards I migrated over to eMule for my music fixes. During all of those years, Winamp was my player of choice.

Winamp wasn't all about playing pirated songs. I ripped most of my hundreds of CDs with Exact Audio Copy to MP3 and eventually to lossless formats. You could play them on your laptop, PC and of course the little portable player from a certain fruity company. The iPod was certainly a major brick in Apple's road to world domination via the iPhone in the years ahead.

As we came to the late 2000s, the speed of internet connections improved, HD video became popular and Winamp didn't adapt. The software player market became ever more saturated, and other better developed and featured apps took market share from Winamp. It lost its mojo in the 2010s, as monetisation and streaming happened. Winamp never adapted to this new way of doing business and active development ceased in 2013. One wonders that if there was some more visionary and adaptive management, there's little reason that Winamp couldn't have gone to the stars and become as widely known as Spotify or iTunes is today.

Perhaps its greatest strength was its community of developers and the easy integration of plugins. Back in the 2000's, lossless audio was in its nascent days. As the proud owner of some overpriced Hi-Fi equipment, I was compelled by the need to try and get the best quality audio possible, and would acquire (cough) or rip as much lossless audio as I could. FLAC and APE plugins were absolutely essential, as was CUE support.

So, armed with the plugins I wanted, my playlists and favorites set up just the way I like, there was absolutely zero need to change my music player. In fact, I only stopped using Winamp in the last few years in favor of Media Player Classic, which was more for its lightweight nature and video playback capabilities.

I downloaded the new Winamp 5.9 RC1 and it's just as I remember. Its playlist management remains amazingly customisable and I always loved just how easy it was to find a certain song or album. The visualisations hold up even today. Though they never particularly 'moved with the beat', they are varied enough to remain as attention grabbing and look as psychedelic as ever.

Now that Winamp is back, it has compatibility with Windows 11 and active development is underway, I'm 100 percent sure that Winamp will again become one of my essential applications. My MP3 folder has files dating back 25 years. They've been digitally dusted off and they're there again in Winamp, just as they were in decades past.

Welcome back Winamp! Here's to another 25 years of llama arse whipping. ■

Chris Szewczyk

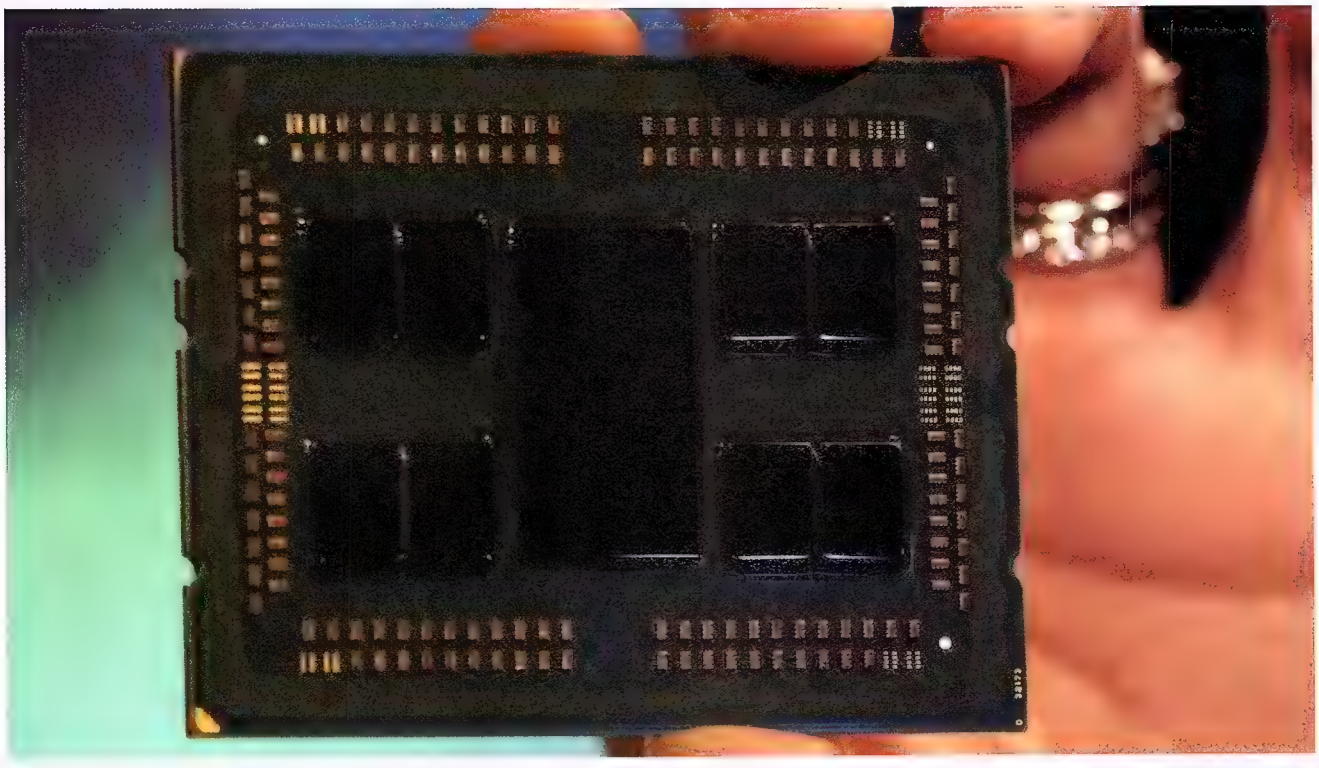
WINAMP
WINAMP EQUALIZER
WINAMP PLAYLIST
1. Parokya Ni Edgar - Halaga 5:51
2. Parokya Ni Edgar - Parokya Ni Ed... 3:44
3. Parokya ni Edgar - Parokya ni Edg... 3:15
4. Parokya Ni Edgar - Parokya Ni Ed... 2:15
5. Parokya ni Edgar - Sayang 3:00
6. Parokya ni Edgar - Alumni Homec... 4:41
7. Parokya Ni Edgar - Parang Ayoko ... 5:31
8. Parokya ni Edgar - one and only you 2:48
9. Parokya ni Edgar - Sorry Na 4:11
10. Parokya Ni Edgar - Wag mo na s... 3:01
11. Parokya Ni Edgar - Inuman Na 4:04
12. Parokya Ni Edgar - Telepono 5:56
13. Parokya Ni Edgar - Okatokat (feat.... 4:20
14. Parokya Ni Edgar - Kaleidoscope ... 4:43
15. Parokya Ni Edgar - Pumapatak An... 2:57
16. Parokya Ni Edgar - Pangarap Lan... 3:14
17. Parokya Ni Edgar - Buloy 4:19
18. Parokya Ni Edgar - Paldusap Lan... 3:12
19. Parokya Ni Edgar - Akala 3:02
20. Parokya Ni Edgar Feat. Francis M... 3:29
WINAMP LIBRARY
Local Library
Audio
Video
Most Played
Recently Added
Recently Modified
Recently Played
Never Played
Top Rated
Playlists
Online Services
Devices
Podcast Directory
Subscriptions
Bookmarks
History
Search
Artist
Album
Parokya Ni Edgar
Parokya Ni Edgar Feat. F...
(no album)
Bigotilyo
edgar edgar musikahan
Gulong Ilog Gulong
Halina Sa Parokya
Inuman Sessions vol.1
Inuman Sessions, Vol. 1
Kami nAPO Muna Tribute...
Middle-Aged Juvenile No...
music
Solid
Length
Genre
Rating
Parokya ni Edgar Bigotilyo 1 Alumni Homecoming 4:41 Other
Parokya Ni Edgar Bigotilyo 6/17 Parang Ayoko Na Yata 5:31 Alternative
Parokya ni Edgar edgar edgar musikah... 7 Sorry Na 4:11 Rock
Parokya Ni Edgar Gulong Ilog Gulong 5 Wag mo na s... 3:01
Parokya Ni Edgar Gulong Ilog Gulong 16 Inuman Na 4:04 Alternative
Parokya Ni Edgar Halina Sa Parokya Telepono 5:56
Parokya Ni Edgar inuman Sessions vol.1 6 Okatokat (feat. Jay of... 4:20 OPM
Parokya Ni Edgar inuman Sessions, Vo... 17 Kaleidoscope World 4:43 OPM Alter...
Parokya Ni Edgar Kami nAPO Muna Tri... 1 Pumapatak Ang Ulan 2:57 OPM
Parokya Ni Edgar Middle-Aged Juvenile... 5 Pangarap Lang Kita F... 3:14 Other
Parokya Ni Edgar music Buloy 4:19 Other
Parokya ni Edgar music Paldusap Lang (Live... 3:12
Parokya Ni Edgar Solid 8 Akala 3:02 Rock
Parokya Ni Edgar Feat... music Bagsakan 3:29 Other
Play
20 items [1:17:33] [80.30 MB] in 0.002 sec.

Winamp is so customisable you can have it as minimalist or bloated as you like.

© GamingPH

AMD kills off non-Pro Threadripper

HEDT (High-End Desktop) platforms once reigned as the fastest CPUs available, targeting enthusiasts who wanted more.



The Threadripper Pro 5000WX line is the same as the EPYC workstation line now, but without dual sockets.

Intel created the HEDT space with socket LGA1366 in November 2008, and for a while the Core i7-920 was one of the best enthusiast processors. It was the first consumer four-core/eight-thread CPU, running at 2.66GHz base and 2.8GHz boost.

The thing is, you could crank the voltage up a bit and set the BCLK to 190/191MHz and suddenly you had a chip running at 4GHz. From 2009 until 2017, Intel didn't bother selling mainstream desktop CPUs with more than four cores to the masses. If you wanted something better, you had to move up to HEDT. There were six-core Gulftown CPUs in 2010, Sandy Bridge-E and Ivy Bridge-E stayed with six cores but moved to quad-channel DDR3 memory controllers, and Haswell-E increased the core count to eight in 2014, swapping to DDR4 at the same time. Broadwell-E and the Core i7-6950X topped out at ten cores and 20 threads.

AMD was nowhere to be found in the HEDT space, with the languishing Bulldozer derivatives trailing Intel CPUs that were several years old. And then Ryzen happened. Suddenly AMD was part of the enthusiast CPU story again, offering eight-core/16-thread CPUs at competitive prices. The Ryzen 7 1700 blew past the Core i7-7700K in multi-threaded workloads, all for a lower price, and Intel finally had to move beyond four-core CPUs on its mainstream LGA115x platform.

But AMD didn't just attack the HEDT space with consumer parts; Threadripper was a full-scale assault on Intel's priciest CPUs. Threadripper 1950X gave people 16 cores for $1,450, eclipsing Intel's top solution. The response with Skylake-E and chips such as the Core i9-9980XE might have partially reclaimed the crown for thread counts, but at a much higher power draw. Then AMD doubled down with the second-generation Threadripper 2990WX offering up to 32 cores and 64 threads. It was a blowout of, well, EPYC proportions.

In early 2020, AMD truly put the nail in the Intel HEDT coffin with a 64-core Zen 2-based Threadripper 3990X. Granted, at that point we'd moved well past what even serious enthusiasts might consider buying, as Threadripper 3990X cost a cheeky $6,799. Intel didn't have anything that could compete with AMD's multi-threaded monsters.

But that's the end of the line for regular Threadripper, as AMD now wants to merge HEDT with its Threadripper Pro offerings. Make no mistake, Threadripper Pro is a beast, with an eight-channel memory controller and 128 PCIe lanes. Vanilla Threadripper 'only' offered up to 72 PCIe lanes and four-channel memory support.

At least for the time being, AMD is content to serve the consumer market with products like Ryzen 9 5950X, which mostly kills off the need for Threadripper anyway. HEDT merges into the workstation market, but it's less a merger and more the death of HEDT as an option. Perhaps Intel will try to revive HEDT, but with Core i9-12900K offering 24 cores and 32 threads, and the Raptor Lake chips ready to deliver 32 cores and 40 threads in the near future, the writing is on the wall. Moving to dual-channel DDR5-6400 should also mitigate bottlenecks from dual-channel memory controllers.

So, farewell HEDT. It was a good run while it lasted.

Jarrod Walton ■

TRADE CHAT

Intel's PC platform problem

The comeback isn't quite complete, with some significant hurdles still to face.

You can read all about the future of the PC platform in our feature article on page 66, and the bottom line is an increase in bandwidth across the board. But the PC platform is not monolithic, instead, it's bifurcated between Intel and AMD. And increasingly, it looks like AMD will have an advantage for some time.

The issue involves PCIe connectivity, specifically PCIe connectivity for M.2 SSDs. As explained in the platform feature, Intel made it first to market with PCI Express 5.0 support with 12th Gen Alder Lake CPUs and the 600 series chipset. The catch is that it's limited to 16 lanes, which means no native PCIe 5.0 for M.2 storage slots, with add-in cards required for most 600 series motherboards to support PCIe 5.0 SSDs.

There are a few exceptions. In other words, there are Intel Z690-based motherboards with native PCIe 5.0 M.2 slots. The catch is that to use them, you have to pinch lanes from the PEG-16 slot, cutting the bandwidth available to the graphics card in half. One can argue whether that matters for existing GPUs. But the chances of performance being compromised will only go up when new GPU tech arrives later this year and thereafter.

Notably, AMD is promising that the new AM5 socket and Ryzen 7000 CPUs will have sufficient PCIe 5.0 lanes to support both full 16-lane graphics links and native M.2 storage in parallel. Advantage AMD? Yes, and that doesn't look likely to change any time soon. For starters, Intel's next platform for 13th Gen Raptor Lake CPUs carries over exactly the same chipset hardware and PCIe connectivity. Making matters worse, the latest news on Meteor Lake, the 14th Gen CPU family that follows Raptor Lake, is they have been pushed out to the end of 2023 at the earliest thanks to problems with Intel's new 7nm production process, branded Intel 4.

In fact, there are rumours that Intel 4 is proving so problematic that Intel may have to go begging to Taiwanese foundry TSMC to help with Meteor Lake CPU core chiplet production (TSMC has already been booked to produce Meteor Lake's integrated graphics chiplet). So even if Meteor does bridge the PCIe 5.0 gap, it looks likely that AMD will have the market to itself for at least 18 months when it comes to what you might call a proper PCIe 5.0 storage solution. OK, actual PCIe 5.0 SSDs remain the stuff of marketing slides, but a year from now they will be widely available and cranking out as much as 14GB/s on AM5 motherboards.

In other words, when you add in Intel's apparent troubles with its new Arc graphics cards, which are now long overdue and look set to disappoint in performance terms, it's hard not to conclude that Intel's woes continue.

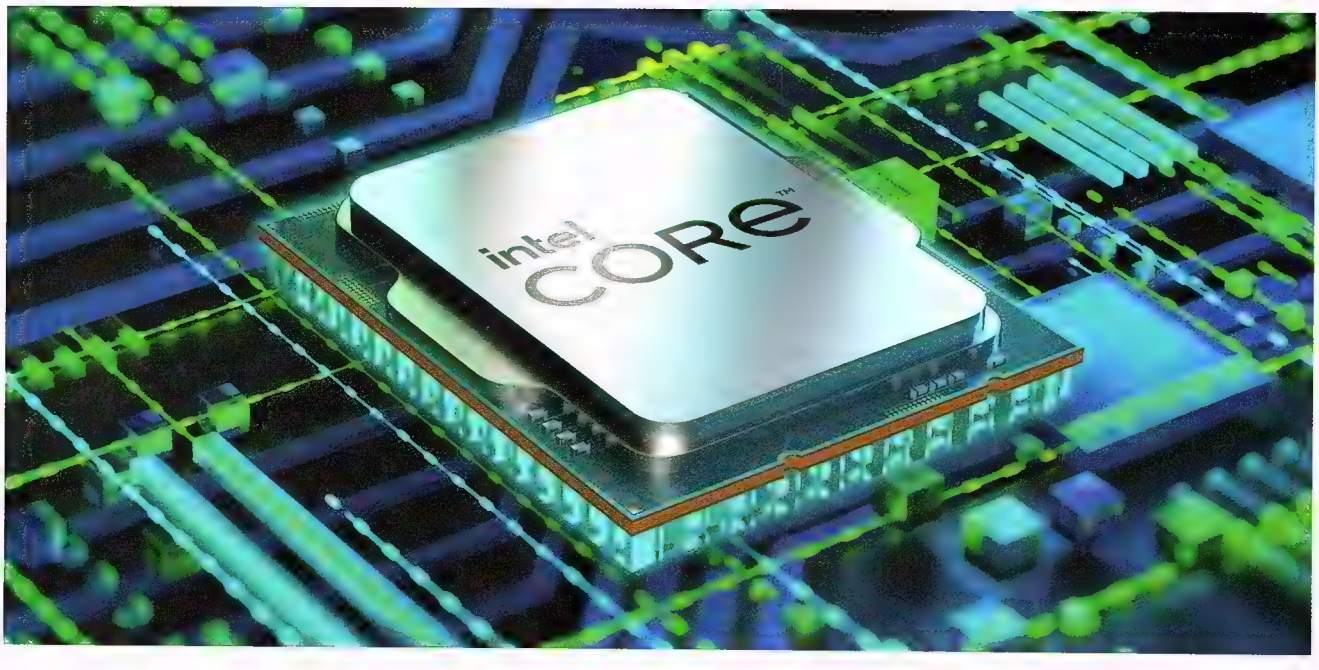
Meanwhile, Intel is giving its upcoming Raptor Lake CPUs an additional eight efficiency cores along with extra single-threaded performance to an architecture that already has the best IPC on the market. I expect Raptor Lake to have the edge for both single and multi-threaded performance.

> "The PC platform is not monolithic, instead, it's bifurcated between Intel and AMD."

So, it's not all bad news for Intel. But clearly, the PC's biggest beast hasn't entirely got things back on track. If Intel can't get its Intel 4 process technology under control, its long-term prospects will become a genuine worry.

Jeremy Laird ■

Six raw 4K panels forbreakfast, laced with extract of x86... Jeremy Laird eats and breathes PC technology.

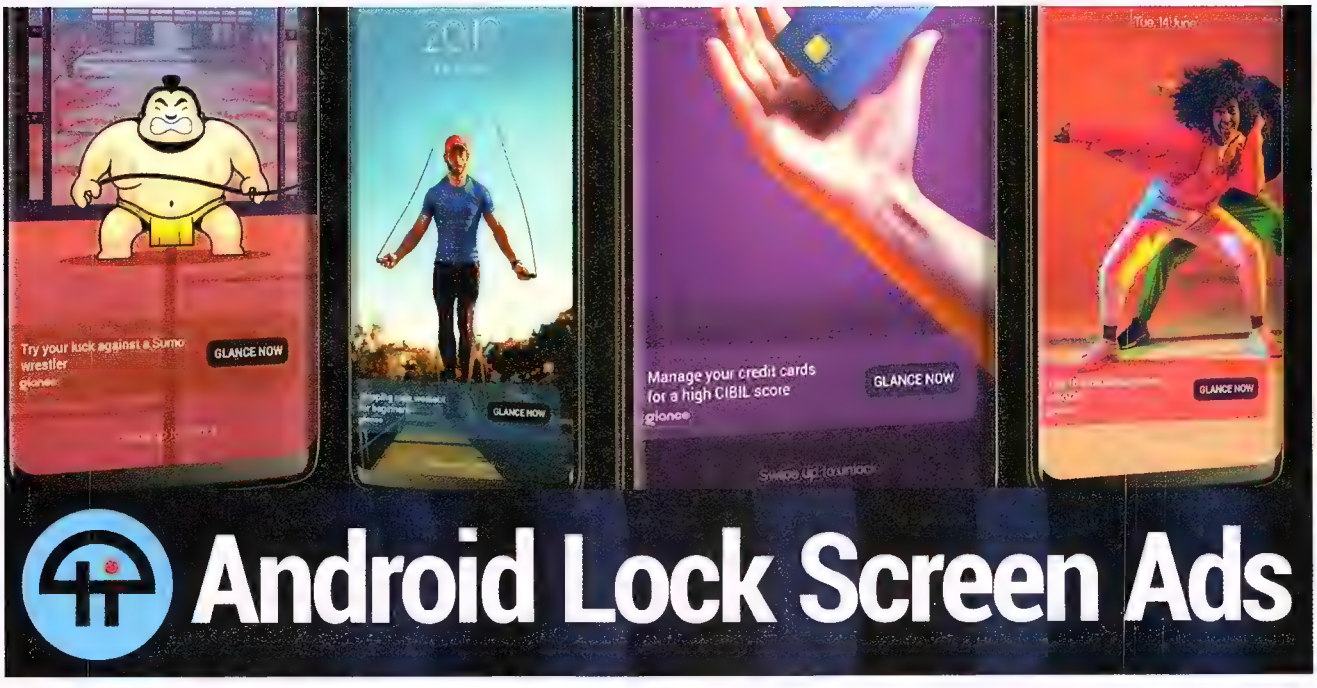


The Raptor Lake CPU may not have native PCIe 5.0 M.2 storage support.

ONE MORE THING

A plea for sanity and respect

Pollution of the internet we consume is only getting worse, says Jon Honeyball, and the time to act is now.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Android Lock Screen Ads

It seems that every day we read about pollution around the world. Like the growing horror of microplastics: small chunks of plastic officially defined as being smaller than five millimetres in diameter. Now I read that microplastics are being found inside living creatures.

The pollution problem is getting worse in our own world of computing and the internet, except here it is mostly related to a tidal wave of advertising material. Some of it is obvious, with websites that are often more advert than content a particular bête noir of mine. Other adverts are more insidious, such as those injected into video streams on YouTube. I understand the need for advertising revenue, and that I can pay the monthly YouTube fee to get rid of the inserted adverts, but this doesn't rid me of the almost endless product placements made within the video itself.

It doesn't stop there, of course – buy a new computer and you can rest assured that there is a wheelbarrow full of rubbish to be immediately uninstalled, starting with the ubiquitous antivirus trialware. I strip laptops back to the bare minimum, keeping only necessary vendor-supplied tools for updating firmware and drivers.

So you can imagine my horror at reading reports that a company, Glance, is about to launch its lockscreen tool for Android phones in the USA, and you can bet Australia and the rest of the world won't be far behind. It replaces the standard lock screen with its own platform and, as you can probably expect, this means adverts can be delivered directly to this screen. Although the company insists that it isn't an ads platform but a "smart surface".

Adverts have their place, but only if there is a clear understanding that the costs to the end user are reduced, often to zero, by accepting the adverts. That requires a clear understanding that you either get the adverts, or you can pay a small subscription and get the clean feed. However, no one wants to engage in that discussion, mostly because it requires them to put a value on the advertising feed, and thus onto the end user uptake.

It really is about time that there was clarity in this space. Buy a laptop with all the crapware installed and pay a price. Pay slightly more and get it without. Then I can choose, based on the cost of my time, to clean things up.

At the same time, we need to talk about online advertising and its place in our lives. And this is before we even get onto the enormous amount of user profiling that is happening in real-time of each and every internet user, and the question of where and how that data is being used.

I absolutely would not buy a smartphone that had built-in advertising of the form provided by Glance. Telcos have no right into my phone operation other than providing raw connectivity.

It is no longer acceptable to just sit back and assume that we are going to get swamped, and that there is nothing we can do about it. All that will happen is that that the pollution will grow and mutate until, like microplastics, it's so pervasive that we can't even spot it anymore. It's just there, inside our devices. It's time we put these companies back into their box.

> "Adverts have their place, but only if there is a clear understanding that the costs to the end user are reduced, often to zero, by accepting the adverts."

Jon Honeyball ■

Jon is a contributing editor to APC. He will soon be advertising an eshop for trinkets and trash. As revenge.

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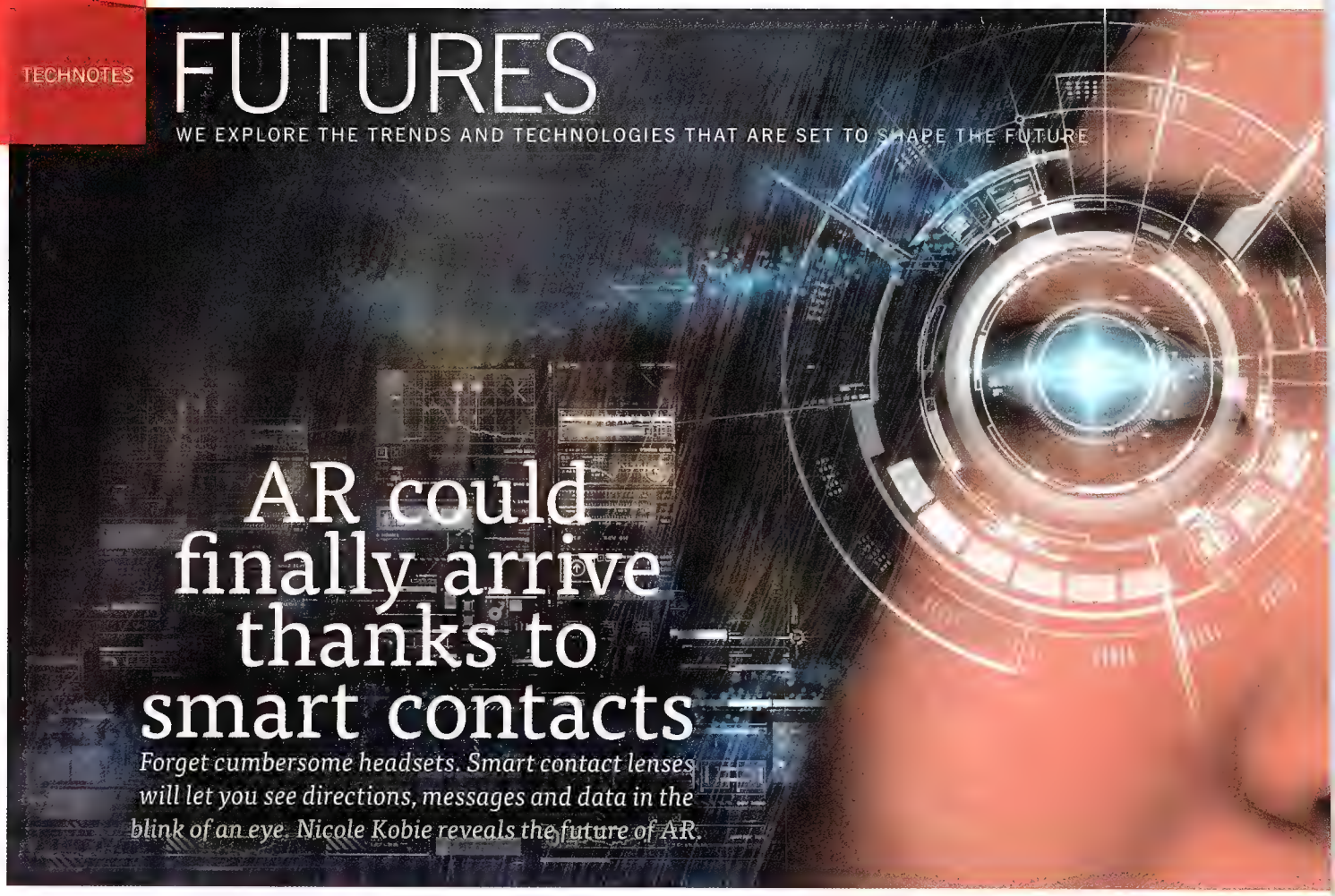


AR could finally arrive thanks to smart contacts

Forget cumbersome headsets. Smart contact lenses will let you see directions, messages and data in the blink of an eye. Nicole Kobie reveals the future of AR.

Augmented reality has had a rough take off – perhaps not a surprise for a technology launched into the public consciousness by Google with skydivers. Almost a decade ago, Google Glass was unveiled at the company's I/O conference by people leaping out of a plane wearing the smart glasses and landing at the Moscone conference hall.

Despite the flashy entrance, Google Glass stalled, held back by privacy concerns and a failure to meet user expectations; rather than letting us view the world with a snazzy sci-fi overlay of information, Glass was like trying to read Twitter from a TV on the other side of the room. Other AR headsets followed, from Microsoft's HoloLens to Magic Leap. And none found real success in the consumer market, though Glass and HoloLens are quietly being useful in medical and enterprise settings (see box, p24).

Now a set of smart contact firms are hoping for another shot at the consumer AR market. Mojo Vision announced earlier this year that its Mojo Lens was ready to go and only awaiting regulatory approval, while InWith unveiled its version at CES in January. At a high level, the ideas are the same: cram contact lenses with miniaturised circuits so they can communicate with smartphones to display information to the wearer. Mojo Lens is a hard contact lens (see box, opposite), while InWith is a soft lens, the type more commonly worn by most people for corrective vision.

Are smart contact lenses the killer device that finally sees AR win mainstream consumer acceptance? Or is it time to admit we're happy looking at our phones when we get a message?

Smart lens

Michael Hayes, co-founder and CEO of InWith, has been working on building flexible electronics into soft contact lenses for just shy of a decade, developing proof of concepts for lens manufacturers. At CES in January, the company showed off its technology, which embeds miniature processors, communications chips, antennas, sensors, chargers, energy storage and more into a tiny lens in order to display images and text to the wearer's eye. Unsurprisingly, the research has yielded plenty of patents, including one for harvesting energy from the blink of an eyelid.

It will hopefully arrive within the next year, Hayes says. "What we're working on right now is regulatory approval of the first version of the lenses," he told APC. "That's priority right now and then we go to market."

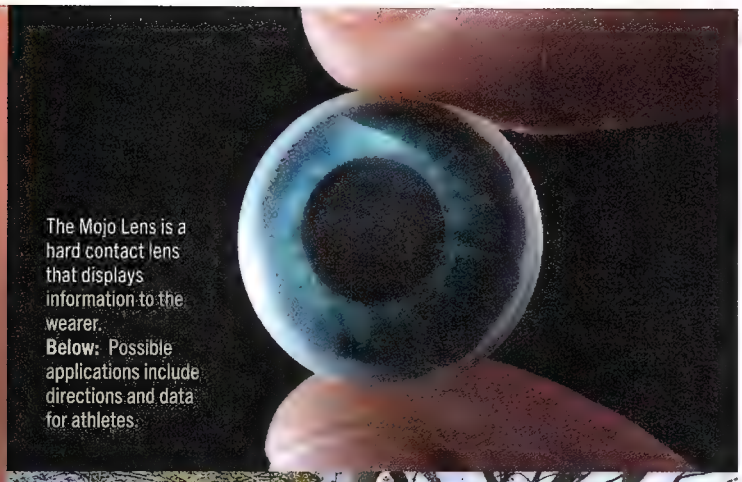
> "Are smart contact lenses the killer device that finally sees AR win mainstream consumer acceptance?"

Lens limitations

Oscar Mendez, lecturer in robotics and AI at University of Surrey, warns that people must understand the technology's limitations, notably that the field of view tends to be small. "Consumers need to be aware that it's not going to be a hugely immersive experience where even your periphery is looking at things," he said. "It's going to be something more targeted."

Hayes says the first versions of smart lens AR will be more of a heads-up display than a fully immersive experience. "It's not going to be like putting on an Oculus Rift right off the bat," he said. "You're not going to be immersed in a 3D game experience, you're going to have information that alerts you to things in your environment, tied to smartphone alerts and cues that you don't currently have in your field of vision without looking at your smartphone."

Of course, hardware is only part of the problem. Mendez works on one potential challenge: camera localisation. If the AR system's camera "knows" where it is, then virtual items can be pinned or "parked" in a spot and stay there – if you leave a virtual note for yourself as a reminder when you return home, it needs to be there when you get back to be of any use, for example. "It's no



The Mojo Lens is a hard contact lens that displays information to the wearer.
Below: Possible applications include directions and data for athletes.

MOJO'S INVISIBLE COMPUTING

Mojo Vision has been working on augmented reality smart contact lenses since 2015, but earlier this year announced it had reached a final technical design for its Mojo Lens. The aim is to let people read key information – messages, directions, fitness tracking, gaming cues – in a heads-up display without having to look down at a screen. Mojo calls this an "eyes up experience" and "invisible computing".

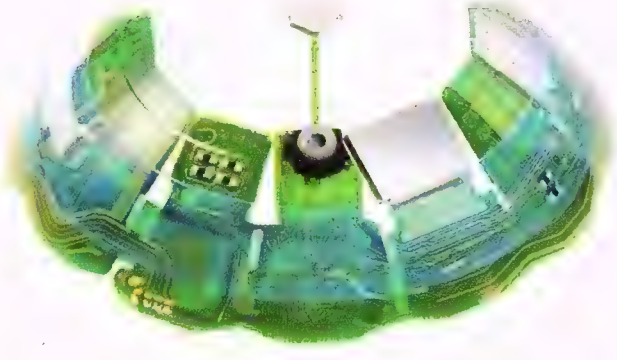
The microLED display is less than half a millimetre wide, with a pixel density of 200 micro pixels per inch, and uses an accelerometer, gyroscope and magnetometer – all sensors common to smartphones – to track eye movements to make overlaid images look still.

That's managed using a custom application-specific integrated circuit powered by an ARM Core M0 chip and 5GHz radio to pull in content and push out sensor data using a proprietary communications protocol that the firm claims is faster and more efficient than Bluetooth LE. And all of that is powered by medical grade micro batteries managed by another proprietary system. As wearers need to be able to interact with their Mojo Lens, the company has created a user interface that relies on eye tracking.

"In the new prototype, our software team has built foundational operating system code and user experience (UX) components for the first time," wrote CTO Mike Wiemer. "The new software will allow for further development and testing of important use cases for our partners and future customers."

While it's too early to know exactly how this smart lens will be used, Mojo Vision has already signed partnerships with a range of sports and fitness companies, including Adidas Running, Slopes for winter sports and 18Birdies for golf. "The goal is to deliver training data and real-time stats in an eyes-up, hands-free way to improve focus and flow," Wiemer wrote. "Athletes and sports enthusiasts crave insights, but current wearables don't effectively deliver in-the-moment or during data."

At the time of writing, the Mojo Lens was still awaiting regulatory approval. But with a technical design and first prototypes available – CEO Drew Perkins trialled the first version himself at the end of June – AR contact lenses could be on the horizon.



longer just a heads-up display that goes where you go, it's grounded in the real world," he said. "And I think that's one of the technologies we need to crack properly before we have augmented reality in the way the public expects or hopes."

Systems to manage this exist and are used in larger headsets such as the HoloLens, but achieving the same in a smaller package is a challenge, Mendez explains, particularly when figuring out the trade-off between performance and what people will accept. "Finding that sweet spot between what the human will tolerate in terms of... something moving around a bit will be interesting," he said. "That's more human-computer interaction than it is computer vision."

Above: The Mojo Lens is crammed with miniaturised circuits.

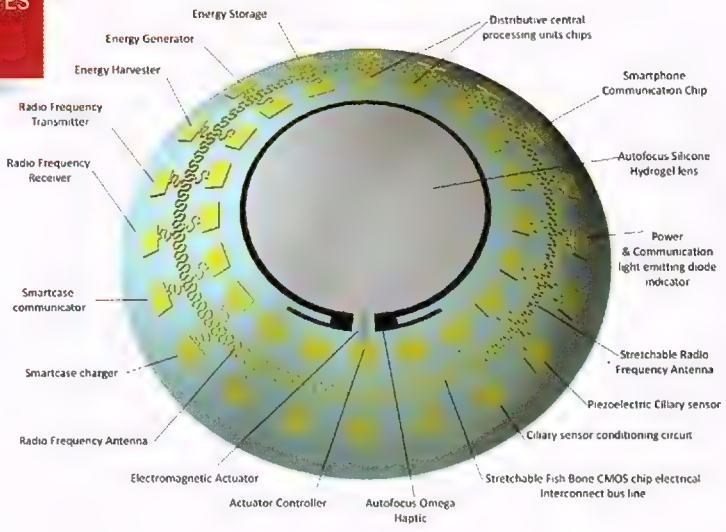
AR in real life

If and when such lenses are approved by regulators – the companies expect that to happen this year – one question remains: do people want AR? Futurist William Higham believes so. "Look at what happened with *Pokémon Go*," he said, pointing to the AR game that exploded in popularity in 2016. "That was the perfect example that the adoption potential of AR is enormous. It's absolutely mainstream.

"I think augmented reality vision products are absolutely the way forward because it's not a solution looking for a problem – it actually potentially solves loads of problems," Higham said. "Using a map for directions on a phone can be problematic, whether you're walking along or driving."

Beyond gaming, AR has a range of potential uses, with Hayes suggesting it could be used for navigation, messaging and instructions. Mojo Lens has partnerships with fitness and sports companies, and it's no stretch to see how runners, cyclists and other athletes might appreciate real-time activity and health data without having to pull out phones or glance at a smartwatch. "The only two places you can put information on the human body that are useful is somewhere around the hands and somewhere around the eyes, and to me the eyes are much better as it's just right there," said Higham.

But Mendez warns that although



The InWith lens embeds processors, chips, sensors, chargers and more into a tiny lens.

AR might seem the best way, people often prefer simpler solutions. He describes research efforts to make a set of instructions to operate a coffee machine work on AR glasses, where one of the main challenges was ensuring virtual arrows pointed to the correct button regardless of where the user pointed their head. Plenty of effort went into solving that tracking issue, but in the end, users preferred simply watching a YouTube video and figuring out which button was which for themselves. "Sometimes the really simple solutions are more enjoyable to the user," Mendez said.

Hayes notes that AR isn't the only use case. InWith's lens can also be used to fine-tune vision, particularly for people suffering myopia or presbyopia, and could one day let us zoom our sight as we would a camera. "This vision correction is the future as well as AR applications," he added. "The whole ophthalmic industry is going to be disrupted."

Privacy problems

Higham argues that the problem with Google Glass wasn't the technology – he admits it wasn't perfect, but still exciting enough – but the privacy issues. "The big problem with Google Glass was the video camera," he said. "It created this kind of media storm... take the video camera off, and I think Google Glass could have succeeded."

Hayes stresses that the first iterations of InWith's smart lenses won't have cameras. "We don't plan on initially introducing a lens like that," he said.

"There will be versions of it where it examines the environment and helps people that have low vision be alerted to things and see better," he clarified. "But incognito filming – we have no plans to make that part of our lenses in the beginning." He adds that market demand could see a camera added in the future, though.

The future of computing?

Mojo's marketing line is that smart contact lenses open up a future of invisible computing, letting users glance at information discreetly rather than hold up a phone to their face or sit at a laptop. While that may one day be possible for the consumption side of computing, it's hard to imagine anyone throwing away their monitor and keyboard in order to create – be it coding or making a PowerPoint – using the limited display in a smart lens. In the short term, at least, smartphones aren't likely to be wholly displaced by smart lenses.

"It's not straightforward that we're going to use these devices in the same way we use our phones," said Mendez. "It's not necessarily going to replace your phone... it's more of an extension of your phone than a replacement."

That said, smart contact lenses overcome the friction of Google Glass and other headsets, and raise the possibility of small steps towards augmented reality, if not yet the full metaverse. Indeed, says Higham, smart lenses may bring ideas like the metaverse into the real world. "I was always a bit wary of these avatars and virtual worlds, so I think that the fact you can do it while still living your real life is great," he said. "With the metaverse, people have got to dial down the sci-fi of it and see it's a tool that's going to make real life easier rather than build some other world." ■

A HISTORY OF AR HEADSETS

Although their contact lenses certainly look smart, Mojo Vision and InWith aren't the first AR vision systems that people have lost their heads(-up displays) over. Here's a short history of recent devices; some are failures, some have found their niche, and some remain to be fully realised.

GOOGLE GLASS (2012)

Google first unveiled its smart glasses at an I/O conference using skydivers, though they weren't available to developers until the following year or the public until the year after that. Though the camera sparked privacy concerns and the glasses never really took off as a consumer product – those who did wear them were dubbed "Glassholes" – the enterprise version has had more success and been used in surgery and even to coach breastfeeding.

MICROSOFT HOLOLENS (2015)

Developed off the back of Kinect, a gaming device that tracked movement for the Microsoft Xbox, the HoloLens was first released to developers in 2016 to develop what Microsoft then called "mixed reality". The wraparound headset was bigger than Google Glass, and, like its rival, found more success with enterprise customers than consumers.

SPECTACLES BY SNAP (2016)

These smart glasses were more about content creation, letting users record video and post it to Snapchat – which if you don't recall was the social media site of choice for teenagers pre-TikTok. Initially sold in a vending machine – yes, really – they were released for sale online in 2017, with three subsequent editions. The newest versions of Spectacles are more focused on displaying AR content, but so far are only available for developers.

MAGIC LEAP (2018)

Founded in 2010, this company was cloaked in secrecy for the first few years of its existence, though that didn't stop it from being handed billions of dollars in funding. Video from the company showed a whale floating in the air above school-children and an elephant stomping around someone's hand, but the excitement turned to disappointment when the device was first revealed in 2018, as initial reactions were critical. The company has since restructured, and the second edition will be designed for businesses.

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$3,099, lg.com

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$3,199, asus.com/au

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$3,750, dell.com/en-au

ALTERNATIVES

HP ELITEBOOK 840 AERO G8

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$2,209, hp.com/au-en

LENOVO THINKPAD X1 CARBON GEN 9

A business laptop with heaps of luxury, especially if you choose the top-end model with a 3,840 x 2,400 screen.

$2,389, lenovo.com/au

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This 2-in-1 convertible is ludicrously light and slim, and offers a quiet keyboard, great performanc, ports a-plenty, and a nice touchscreen.

$2,369, anz.dynabook.com

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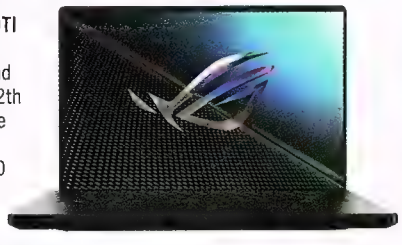
2022 will see an update for all mainstream gaming laptops, and Asus is first to jump in with a 12th gen Core i9 CPU to give 16-core support to the RTX 3070 Ti graphics (a Core i7/RTX 3060 variant costs $2,999). While battery life is only average at around six hours, this laptop's final triumph is fitting a gorgeous 16-inch screen into such a compact chassis.

$4,499, asus.com/au



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LENOVO LEGION 5 (GEN 6)

An RTX 3070 is the star, but it's backed by a high-quality 15.6in 165Hz screen, Ryzen 7 CPU and a solid aluminium chassis.

$2,295, lenovo.com/au

ASUS ROG STRIX SCAR 15 (2022)

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ALTERNATIVES

LENOVO YOGA SLIM 7 PRO

A powerful, well designed ultrabook with an awesome OLED screen for a good price. The original 2-in-1 bends into a new clamshell shape.

$1,949, lenovo.com

HP ENVY 13 (2020)

It may not be the world's most exciting laptop, but the Envy 13 is a compact and forward-looking machine that's ideally suited to these homeworking times.

$1,699, store.hp.com

ACER SWIFT 3X I7

The headline feature is undoubtedly that it features Intel's new discrete GPU – the Iris Xe Max Graphics. It's available with either an i7 or a Core i5 CPU.

From $1,049, acer.com.au

CHROMEBOOKS

ASUS CHROMEBOOK FLIP C436F

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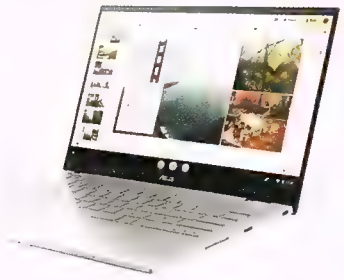
The Flip C436F is a fast, flexible laptop with a slim magnesium alloy chassis that's easy on the eye. With a 256GB SSD, a Core i5 processor and fantastic 14-inch Full HD screen, it's a fine choice for demanding users.

$1,419, amazon.com.au



ASUS CHROMEBOOK CX9

Aimed squarely at business users, this exceptionally quick machine – with a Core i7 processor, 16GB of RAM and a 512GB SSD – drips quality throughout its aluminium alloy chassis. Add a glossy 4K 14-inch screen, plus a low weight of just 1.05kg, and it justifies its high price.

$1,579, asus.com/au

LENOVO IDEAPAD DUET

The Chromebook answer to Microsoft's Surface tablets, this is a seriously versatile device – albeit not the speediest (although we never found it to be painfully slow while carrying out everyday tasks). For this price, and with a 16hrs 14mins battery life, the Duet is a great choice.

$447, lenovo.com/au

TABLETS

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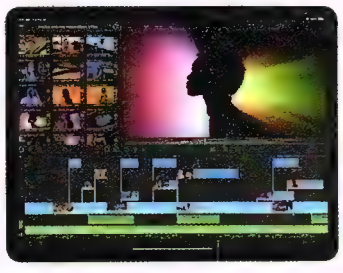
Blurring the boundaries between laptop and tablet like never before, the M1-powered iPad Pro 12.9-inch is every bit as fast as we expected – and the "Liquid Retina XDR" display is simply phenomenal. **apple.com/au**



APPLE IPAD (2021)

Apple performs its usual trick of upgrading just enough to keep the iPad affordable and up to date, without treading on the toes of its more luxurious stablemates. The big bezels remain, but a faster processor, more storage and improved camera all add to its appeal.

From $449, apple.com/au

SAMSUNG GALAXY S8 ULTRA

The Samsung Galaxy Tab S8 Ultra is an enormously impressive tablet. It makes a fantastic first impression with its gorgeous screen and thin body, and is great for multitasking. If you want the best Android tablet going, there's no question at all that this is it.

$1,598, samsung.com

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PHILIPS BRILLIANCE 346P1C

34-INCH CURVED DOCKING,

No-one can match Philips for its mix of quality, features and value, especially when it comes to curved MVA monitors such as this. It's great for casual gamers and busy workers alike, with USB-C docking and superb colours.

$849, philips.com.au

EIZO FLEXSCAN EV2480

Businesses in particular will love this easy-to-roll-out 24-inch monitor, with its exceptional five-year warranty, USB-C port for easy docking, excellent viewing angles and delicious whites. And it has the best OSD around.

$699, eizoglobal.com

DAHUA DHI-LM28-F420

This affordable 4K monitor might not offer much in the way of menu options or high-end gaming perks, but it offers impressive resolution and colour for a fraction of the price you'd normally pay.

$269, dahuaaustralia.com.au

PROFESSIONAL MONITORS

EIZO COLOREDGE CG319X

CREATIVE MASTERCLASS, $7,119

As the price indicates, this monitor is for heavyweight creatives who demand the best in every discipline: HDR video editing, print layouts, professional photography and more besides. With superb coverage and accuracy across all spaces, plus a built-in calibrator, it justifies the investment.

$7,119, eizoglobal.com

BENQ PD2725U

By no means a cheap 4K 27-inch monitor – unless you compare it to the Eizos – but it marries all-round quality with ease of use thanks to a puck that allows you to quickly move between settings. You can even daisy chain a second Thunderbolt 3 monitor for a monster setup.

$1,799, benq.com

EIZO COLOREDGE CG279X

Designers who need to work across different disciplines will love how easy it is to switch between the Adobe RGB, DCI-P3 and sRGB colour spaces using the Eizo's fantastic OSD. It's certainly not cheap for a 27-inch 1440p monitor, but it's packed with quality.

$3,095, eizoglobal.com

HOME OFFICE PRINTERS

EPSON ECOTANK ET-1810

BACK TO BASICS

There's nothing flashy about this bottle- fed inkjet: it's there to churn out pages at a decent rate (8.8ppm for black text) for a low price. It comes with enough ink for 4,500 black pages and 7,500 in colour, but refills are cheap. Just don't expect features like duplex printing.

$299, epson.com.au

CANON PIXMA PRO-200

Yes, it's big and it's expensive – and you don't even get a scanner – but the Pixma Pro-200 means that you can print A3 photos with glorious colour accuracy and detail. If you're after an office workhorse, look elsewhere, but it can't be beaten on photo quality.

$809, canon.com

BROTHER MFC-J4540DWXL

Home workers will love this inkjet all-in-one. It combines an incredible range of features with all the connectivity you need and extreme ease of use. Output quality is fine, it offers the best cloud support around and the high-capacity ink pack could keep you going for years.

$420, brother.com

WIRELESS ROUTERS

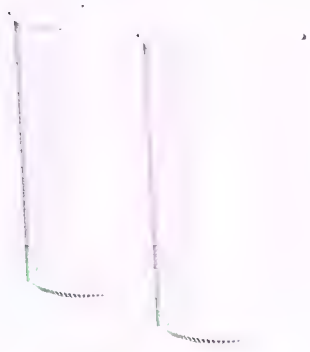
SYNOLOGY RT6600AX
FAST & LADEN WITH UNIQUE FEATURES
Fast, well-featured and secure, the Synology RT6600ax is as perfect for professionals and prosumers as much as it is for SMBs and smart homes.
$599, synology.com/au

ASUS RT-AX82U
The impressive RT-AX82U punches well above its price when it comes to raw Wi-Fi 6 performance and includes a fistful of useful features – such as an ultrafast 20Gbits/sec USB connector, outbound VPN support, site-blocking and a host of parental controls.
$320, asus.com/au

HUAWEI WS7200
This affordable Wi-Fi 6 router delivers consistently fast wireless speeds, broad coverage and a modest speed boost for newer hardware – and the Router 3 has a cute design too. If you need more range, you can pick up a second unit to use as an extender.
$120, huawei.com

MESH WI-FI

TP-LINK DECO X90
SUPERB WI-FI 6 MESH
Welcome to the new generation of Wi-Fi 6 meshes, with greater range and consistent speeds for both upload and downloads. TP-Link reckons these two units will cover a six-bedroom house, and they each include 2.5GbE ports too.
$699, tp-ink.com



TP-LINK DECO X20
The price below isn't a typo: the Deco X20 makes it possible to upgrade your home network to Wi-Fi 6 – as well as manage its security – for the price of some standalone routers. The included HomeCare functions are also a great bonus for households where lots of devices are fighting over the bandwidth.
$199, tp-link.com

ASUS ZENWIFI AX
The interface and design certainly aren't the prettiest (the nodes look like mini space heaters, while the charcoal version is straight out of the 1980s), but if you're after strong performance, great features and plenty of expansion potential, the ZenWiFi AX is a compelling prospect.
$949, asus.com/au

NAS SERVERS

QNAP TS-130
SIMPLE HOME NAS
An above average CPU and RAM combo, solid features and affordable price make the QNAP TS-130 worth considering. Alternatively there's the two bay TS230 which features the same CPU, with 2GB of RAM, dual drive bays, and an extra USB port on the front for a modest $50 price increase.
$250, qnap.com

NEW ENTRY

ASUSTOR NIMBUSTOR AS5304T
This is a hugely powerful four-bay NAS that will be overkill for most people – not just due to its speed but also its slightly intimidating user interface – but techies and gamers should investigate the Nimbustor AS5304T for both its speed and flexibility.
$799, asustor.com

SYNOLOGY DISKSTATION DS1522+
At $1,199 it's not cheap but factoring in the software means it's great value. Though some internal silicon may lack headroom, this is still a well-featured, expandable NAS with fantastic software. The best part is the DSM software.
$1,199, synology.com

SECURITY SOFTWARE

F-SECURE SAFE
F-Secure concentrates on the basics: faultless protection with minimal impact on your system's performance – for a low price.
1-3 PCs, 1yr, $99.99, f-secure.com

NORTON 360
Consistently on the podium in our group tests, and loaded with an abundance of genuinely useful features, including a VPN and generous cloud backup.
1 PC, 1yr, $79.99, nortonlifelockpartner.com

AVAST FREE ANTIVIRUS
For the second year running, Avast is our top pick for free antivirus software – it's simply lighter on its feet than Microsoft Windows Security, whilst offering fewer false positives.
Free, avast.com

VPNs

NORDVPN
NordVPN provides consistent and fast speeds, serious security, great support for video-streaming services and some cost-effective subscription rates.
$59 per year, nordvpn.com

PROTONVPN
ProtonVPN provided one of the best free offerings of all the VPNs in our group test, including unlimited data, but upgrade to benefit from even faster speeds and many more options.
Free, protonvpn.com

SURFSHARK
A strong rival to NordVPN, especially if you're willing to commit to its two-year contract. It's fast, cheap and a fine choice for people who like to switch to US streaming services.
$66.34 for one year, surfshark.com

PASSWORD MANAGERS

BITWARDEN
Bitwarden has a huge advantage: it's free. It isn't as slick as some paid-for rivals, but it can sync passwords across all devices for no extra charge.
Free, bitwarden.com

DASHLANE
A manager that's ideal for beginners, and it even builds in an unlimited (if basic) VPN service. Note you may prefer to buy the Family plan ($60 per year) as this extends the service to six people.
$55.99 per year (Premium), dashlane.com

1PASSWORD
1Password is targeted at technically minded users who are looking for the last word in security. It even offers a Travel Mode that may ease your mind if surrendering your phone to customs officials.
$54.99 per year (individual), 1password.com

The top five gaming laptops

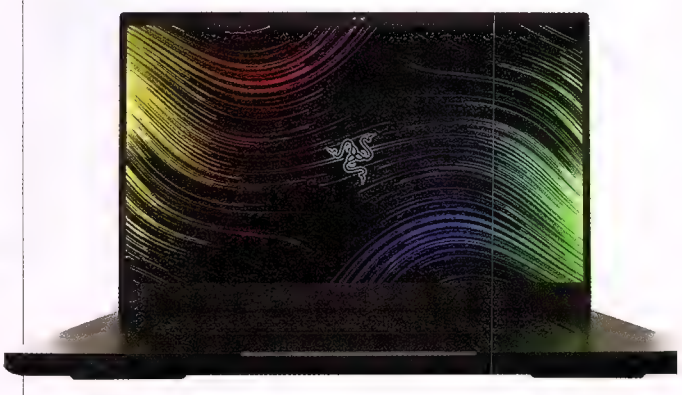
Gaming laptops are a contentious issue here at APC, with some of our writers loving them and others loathing them. Regardless, they remain a common entry point to PC ownership for many, thanks to their versatility, portability, and generally high-power performance. These are the best gaming laptops out there right now across a range of sizes, styles, and budgets, so you can get your game on no matter where you are or what you're doing.

1

LENOVO LEGION 5/5I PRO

Simply the best gaming laptop for most people, Lenovo's machine perfectly balances power, features, and price. The main attraction is the huge 16-inch 16:10 165Hz G-Sync display, which is fantastic for gaming and work, while also fitting into a 15-inch chassis. It also has four-zone RGB lighting and superior internal cooling, and it's dead easy to upgrade RAM and storage.

From$2,295, www.lenovo.com



2

RAZER BLADE 15/17

Razer's gaming laptops are still the sleekest around, thanks to their gorgeous CNC-milled aluminum chassis and lightweight 2.2kg body (on the 15-inch model, at least). The newest models rock Intel's 12th Gen processors, although it could be worth looking at the 11th Gen models if you find them on sale. That's because the one thing Razer laptops aren't is cheap. ***From $3,749, www.razer.com***

3

ASUS ROG ZEPHYRUS G14

If you want a gaming laptop without all the bulk that implies, the ROG Zephyrus G14 is the compact and lightweight model to go for. That doesn't mean it skimps on features, though, as it includes a large 16:10 aspect ratio screen, 120Hz refresh rate, and a beastly AMD Ryzen 6900HS processor. In fact, it's an all-AMD machine, thanks to the RX 6800S or RX 6700S GPU options.

From $2,199, www.asus.com

4

ACER PREDATOR HELIOS 300

With its $1,500 sticker price, the 15-inch Predator Helios 300 provides high-end 1080p gaming at a mid-range price. It combines everything most gamers need, with an RTX 3060 GPU, Intel 12th-gen CPU, and 144Hz screen. It's also relatively thin and light, and has a one-touch overclocking feature for when you need maximum performance.

From $2,248, www.acer.com

5

HP VICTUS

If you're looking for a good value gaming laptop, HP's Victus line is a good place to start. They still feature luxuries such as a 16-inch display, but save money with modest specs that still pack a punch, such as a Ryzen 7 processor, RTX 3050 Ti GPU, and 16GB of RAM. They also look particularly sleek too, which is to say they look nothing like most gaming laptops.

From $1,599, www.hp.com

HEAD TO HEAD

WordPress vs. Wix

Which website-building platform should you use?

■ WORDPRESS | WordPress Free $free, WordPress Personal $5/month | www.wordpress.com
■ WIX | Wix Combo $15/month, Wix Unlimited $23/month, Wix Pro $30/month | www.wix.com

Publishing a personal website was once costly and complicated. But not any longer. User-friendly platforms such as WordPress and Wix enable you to publish online for free – you might not even need to pay for hosting. They give you everything you need to design and populate your site, maintain it, and interact with visitors. It's estimated that nearly half a billion sites are built on WordPress, while upward of 200 million people use Wix.

If you want to get started for free, WordPress enables you to host a site as a subdomain of WordPress.com, which means you don't need to worry about configuring databases or keeping your site up to date. The downside is that by default your site lives within a subdomain, such as **http://mysite.wordpress.com**. If you want your own domain to point to a WordPress.com-hosted site, you need to pay $5 per month for the Personal plan; this also lets you remove WordPress.com ads, collect payments, perform basic design customisation, and benefit from unlimited email support.

If you already have a domain, you can run WordPress there. Many web hosts offer one-click deployment of WordPress, and can take care of tracking and installing updates to the WordPress software, along with any themes and extensions you've installed. If your host doesn't offer this, you can upload and configure WordPress yourself. All you need is a server running PHP 7.4 or later, plus either MySQL 5.7 or later, or MariaDB 10.2 or later, which few hosts will have trouble with.

Wix also offers free hosting, though you end up with a more complicated address. It uses both a subdomain based on your username, and a directory based on your site name. So, if your username is "myusername" and your site is "mysite," your "about" page is located at **http://myusername.wixsite.com/mysite/about**.

Although you can't download the Wix source code and host it on your own domain, you can use your own domain name; this costs $15 a month and gets you 3GB of storage. If your only aim is to use your own domain, that's considerably more than the $5 per month WordPress wants.

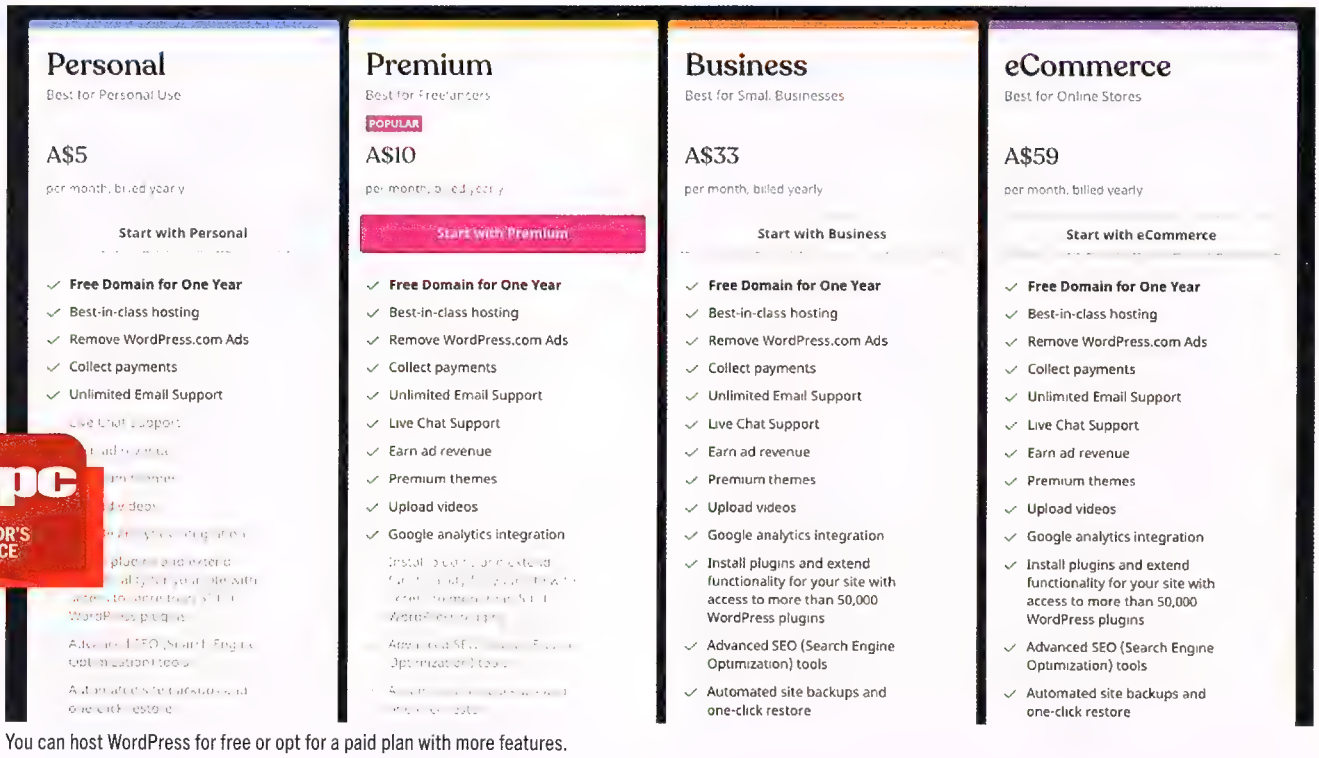
If you opt to host your site at WordPress.com, you're walked through a three-stage process that involves providing your email address, choosing a domain (whether a free subdomain or paid commercial domain), and opting for a plan – the link to "start with a free site" is discreetly displayed at the top of the page, above the more conspicuous charged-for options.

Going live

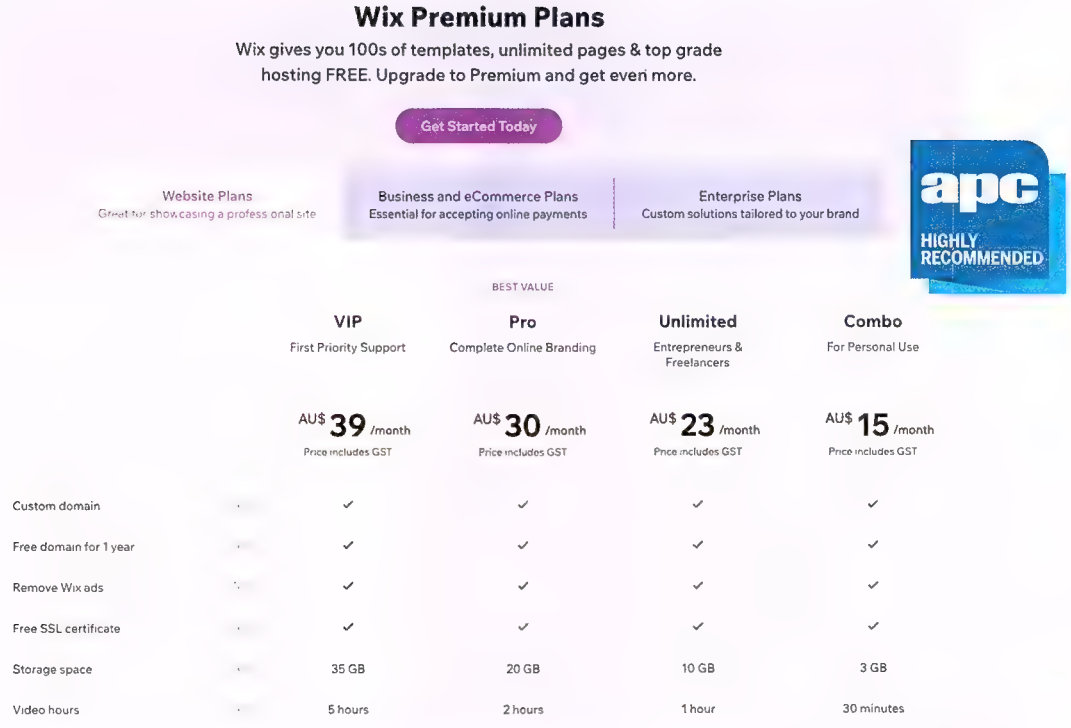
You can then start designing your site or creating an online store if you've signed up for a paid plan. Your first job is to choose a theme; plenty of suggested templates are shown, and you can preview what each one will look like when live. As soon as you've picked one, you're presented with a live placeholder site that you can edit and publish. When you're happy, just click through a few pages and your site is live.

The process with Wix is similar. The site walks you through a series of screens that help you define the goals of your site, then integrate features such as blog pages, chat, and forms. More ambitious tools are available, too, such as music streaming, the ability to take food orders, and sell memberships. Be warned – it may not be obvious, but some of the features offered need to be paid for.

Once you've chosen your elements, you can start building your site using the Wix Editor, which offers large thumbnails and full-screen previews to



You can host WordPress for free or opt for a paid plan with more features.



As with WordPress, you need to pay to get some of the truly useful features on Wix, such as removing ads from your website.

give you a clear impression of what the finished product will look like. Alternatively, you can take advantage of the new Wix ADI, which uses AI to come up with an appropriate design.

Both WordPress and Wix offer dashboards featuring a wide range of tools for managing, maintaining, and monitoring your site, but their approaches are different. WordPress distinguishes between 'pages' – the permanent fixtures such as 'about' and 'contact' pages – and posts, which are more immediate and analogous to blog entries.

The two platforms both let you go beyond the basics by extending their core features. The Wix App Market is neatly categorised and easily searched, with a full description of every app. There's plenty of free content, but also a fair number of commercial add-ons, which don't always have a free tier or trial. A busy reviews system enables users to share their views and allows developers to respond to comments.

When you add an app to your site, Wix warns you which aspects of your code and content it will have access to; once integrated, an app has similar controls to the rest of the editing interface, so it can easily be repositioned by dragging and tweaked using floating control panels.

> "User-friendly platforms such as WordPress and Wix enable you to publish online for free – you might not even need to pay for hosting"

WordPress also offers a mix of free and paid-for plugins through the dashboard. However, if you host your site at WordPress.com, all plugins require a Business subscription at $33 per month, even for those paying for a Personal plan. For self-hosting, no such restriction applies. You can install plugins from the dashboard or upload them to your server manually. As with the Wix App Store, there's an active community of users rating plugins in the catalog, which can be handy because there are often multiple options that do similar things.

WordPress offers apps for iOS and Android, which let you access and manage multiple sites on the go. You can upload images from your phone, write posts or pages, and track your access statistics. There are matching desktop apps for Windows, macOS, and Linux.

Not everyone is in a position to run their own site, of course. If you're looking for a hosted solution, WordPress.com may at first look like the obvious choice, as it's free. However, the fact that you can't install plugins without an expensive subscription means it could well hold you back once you want to develop your site.

It's worth noting that Wix isn't ideally suited to big projects. Officially, Wix sites are capped at 100 pages, and even if you're within that, Wix warns that adding pages can affect loading time and performance. There are workarounds, such as building dynamic pages that draw content out of a database but, by design, WordPress is better suited to managing large sites.

Clearly, your choice of site platform is nuanced. If you want to self-host, WordPress is your only option, and it promises easier options for future growth. However, for a slick all-around experience, Wix shines. The interface is attractive and easy to use, making it a stronger choice for less experienced users or anyone who feels comfortable using page layout software for print.

In the end, you do need to make a decision – once you've built a site in Wix or WordPress, there's no simple way to migrate it to the other platform. However, as they both offer free accounts, you can test the waters by trying out the tools and features on offer, and optionally upgrade to a paid-for service once you're ready to make a commitment. ■

WordPress Free to set up, versatile and easy to export to another provider, though less easy to use than Wix.
Guy Cocker

★★★★½

Wix Simple interface that's easy to set up any type of website. But more expensive than WordPress and with fewer advanced features.
Guy Cocker

★★★★☆

TECHNOTES

Gadgets

Nice little things

❶

PORSCHE DESIGN WIRELESS SPEAKER PDS50

Things that don't look like what they are.

US$449 | From porsche-design.com

Porsche Design is known for its striking, sleek products that turn heads at every opportunity. The company's Wireless Speaker PDS50 is no different, with its imposing tower form and space grey finish making it feel like a monolith from a faraway galaxy.

But this is no space-age relic. The PDS50 is instead a wireless speaker with Bluetooth connectivity, touch controls, and Qi wireless charging. You'll get 20 hours of playback out of one charge, although it does take five hours to completely juice the speaker up.

As with many Porsche Design products, the PDS50 is as much a statement piece as something you'll buy for its audio output. With it at the centre of the room, it will quickly become the main talking point – you'll just need to reassure people it's not an alien artifact.

❷

CAMPFIRE AUDIO SUPERMOON

High quality for the hard of hearing.

$2,199 | From campfireaudio.com

Most people use earphones to listen to music or podcasts, but the format lends itself well to helping those who are hard of hearing. The Olive Max is an attempt to do just that.

It's not just a set of hearing aids. It packs in a raft of clever features, including automatic noise reduction to prevent unwelcome surprises, and adaptive hearing tech that uses AI algorithms to detect your conversations and filter out everything else.

As well as that, the Olive Max earphones manage to look sharp and snappy while still being much more affordable than a regular set of hearing aids. Everything is pulled together by an app that lets you tweak settings, but you can also use the Olive Max without a phone if you prefer.

❸

TEENAGE ENGINEERING TX-6

A magical audio toy.

$1,199 | From teenage.engineering

Teenage Engineering is well known for its quirky, analog-inspired creations that blend nostalgic design with forward-looking experimentation. The company's TX-6 epitomises that with its grey-tinted dials and unexpected extra features.

The TX-6 is a six-channel stereo mixer with a compressor and built-in EQ. It also works as a multi-channel audio interface. Aside from that, it has some interesting bonus features, like its synthesiser and sequencer with four waveforms and four drum sounds. And its tiny shape and battery power makes it highly portable – why limit yourself to a home studio when you can get creative on the go?

It's even customisable, with a knob layout that can be configured to your tastes. With this many features packed into such a small-scale form, what's not to love?

❹

EUFY SMARTDROP

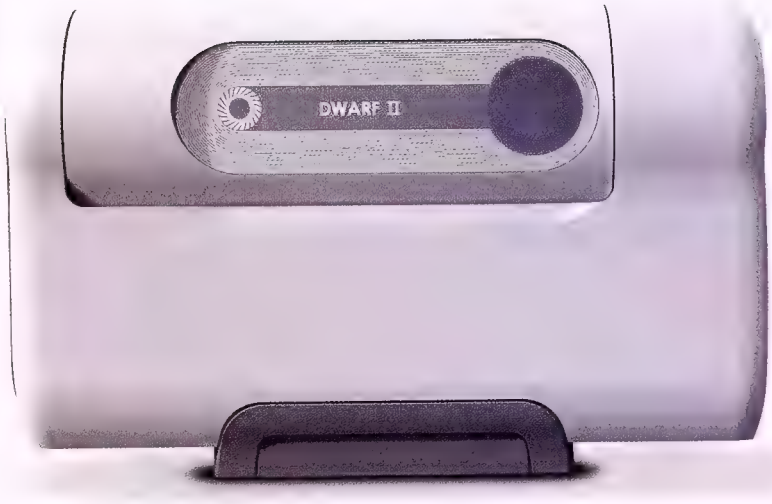
We shouldn't need this...

$570 | From eufylife.com

Getting expensive deliveries while you're away from home can be an exercise in frustration – and anxiety. But instead of simply hoping no one steals your waiting parcel, you can use Eufy's SmartDrop to keep things safe.

The SmartDrop is essentially a large container to store your goods, but it's also much more than that. The device can be opened by delivery drivers using a special PIN, and can then alert the recipient that their package has arrived via iOS. Its metal body is sturdy enough to resist thieves and the elements, and there's plenty of space inside for multiple large boxes.

Not only does that keep things safe, but the device's iOS integration and five ways of unlocking could make it invaluable if you often miss deliveries.



❺

TINYSCOPE DWARF II

Look up.

$TBA | From tinyscope-club.com

Stargazing is a hobby beloved by people the world over, but it it's not the most accessible way to spend your time. Equipment can be expensive, heavy, and bulky, requiring plenty of time and space to enjoy.

The TinyScope Dwarf II, though, could be the answer to these problems.

It's a bite-sized telescope that is many times smaller and lighter than standard alternatives, yet that doesn't mean it falls short on features. It comes with dual lenses (wide angle and telephoto), built-in auto-focus, and remote control using the companion iOS app. And perhaps best of all, it can automatically track objects as they move across the sky – perfect for long exposures.

So, if you love astrophotography but wish it was more accessible, this little camera could be just what you need.

LAPTOP

Apple MacBook Air 2022 (M2)

The 2022 MacBook Air comes with a new premium price tag, but does it have the components to be the heir to the MacBook 13 Pro throne?

■ From $1,899 | apple.com/au

Apple hasn't ever been too concerned about challenging consumer expectations of its products and the new MacBook Air is a great example of this. Not only is the Air range now more expensive than the new MacBook Pro 13 offerings, it's also got a bigger, brighter screen and offers a raft of updated features that the M2 MacBook Pro 13 misses out on.

Apple is going to continue to sell the $1,499 late-2020 MacBook Air with an M1 processor alongside the new MacBook Air for those that are super price sensitive. This has allowed Apple to do a considerable overhaul of the new MacBook Air and bring its base price up to $1,899.

"The M2 processor isn't quite as revolutionary as the jump to M1, but it still puts the processor ahead of Intel's i7-1260P on the units we've tested so far."

Kicking these changes off is a new M2 processor that offers up to 18 percent faster CPU and 35 percent faster GPU performance according to Apple. Internal testing got similar results showing an 11 to 16 percent CPU performance bump compared to the last generation of MacBook Air. We saw synthetic benchmarks even outperform GPU expectations, but games like *Sid Meier's: Civilization VI* jumped from 35 fps averages to 47 using Ultra 1080p settings which is pretty much bang on 35 percent.

So the M2 processor isn't quite as revolutionary as the jump to M1, but it still puts the processor ahead of Intel's i7-1260P on the units we've tested so far. And while the M2 is likely to be one of the biggest single improvements, it's hard to miss the new chassis look. The new all aluminium design brings it in line with the 14 and 16 inch MacBook Pros by swapping out the wedge profile to have a more boxy rectangular shape. This makes it 20 percent smaller in volume overall and just 11.3mm thick.

■ Mac OS Monterey; 13.6-inch IPS display at 2560 by 1664 pixel resolution, DCI-P3 colour, 500nit peak brightness; Apple M2 chip 8-core CPU and 8 or 10-core GPU; 8, 16 or 24GB Unified Memory; 256GB, 512GB, 1TB or 2TB SSD; 53Wh battery (19h6min 1080p movie playback); 30.4 x 21.5 x 1.13cm; 1.24kg.

Despite being more compact, Apple seems to have found enough space to make the screen slightly bigger at 13.6-inches. And while it technically offers slightly more pixels (2560x1664), the main difference in the new screen is that it now offers a 500 nit peak brightness (instead of 400nit), and you can turn the display down to as low as five nits when working in particularly dark environments.

This new design means it also gets a Magsafe charger, a FullHD FaceTime webcam, a new quad speaker Spatial Audio array and a Magic Keyboard with Touch ID. We weren't able to directly test Apple's claims of including a faster Neural Engine and the performance increase from the additional memory bandwidth, however both these technologies were great in the M1 and we didn't find anything to contradict these claims.

Battery life was almost identical to the last MacBook Air, lasting 19 hours and five minutes in 1080p movie playback. It wouldn't be unreasonable to get two days of light work out of it, which is still way more than any other laptop we've tested.

As we've said, the original M1 Air is still available for those on a budget, and if you can't live without your emoji-filled Touch Bar, then you can even buy a MacBook Pro 13 for less than the top MacBook Air, but even amongst this appealing competition the MacBook Air M2 still looks like a standout to us.

	Apple MacBook Air (M2) Mid-2022	Apple Macbook Air Late 2020
Cinebench R23 - CPU (single-core)	1,599	1,494
Cinebench R23 - CPU (multi-threaded)	8,481	7,588
Geekbench 5 - Multi-core (score)	8,896	7,627
Geekbench 5 - OpenCL (score)	27,637	1,894
Sid Meier's: Civilization VI - 1080p, Ultra (fps)	47	34.9
Battery life - 1080p video playback (h:min)	19:05	19:6
Blackmagic Disk Speed Read (MB/s)	3,063	2,700
Blackmagic Disk Speed Write (MB/s)	2,873	2,858

A powerful and quiet ultraportable with an unbeatable battery life and a great pro display.

Joel Burgess

★★★★★

GAMING ULTRAPORTABLE

Asus ROG Zephyrus G14

Asus has doubled down on AMD components in the G14 this year, but is it a winning combination this time around?

■ From $3,499 | rog.asus.com/au

The Asus Rog Zephyrus G14 and G15s have regularly been at the top of our best gaming laptop roundups due to their great performance and reasonable price tags. This market dominance has given the company a bit of cash to splash on updating features like the 1,000-strong LED AniMatrix that can show battery life, audio amplitude animations, or even custom gaming visuals on the outside of the gaming shell.

This new look isn't the only thing this 14-inch gaming rig has going for it though, it's also got a 6th gen AMD CPU and GPU combo, a larger touchpad and a faster screen. The entry-level Zephyrus G14 comes with a Ryzen 7 6800S CPU, a Radeon RX6700S GPU and 16GB of RAM that'll set you back around $3K. Depending on the vendor selling the device you can nab either the FullHD+ 144Hz display or the QuadHD 120Hz panel with full DCI-P3 HDR colour for the same price. Although, if you go by what was still available on shelves, it seems the masses would prefer 24 extra frames to having a brighter, higher resolution and more colour accurate display.

> "The entry-level Zephyrus G14 comes with a Ryzen 7 6800S CPU, a Radeon RX6700S GPU and 16GB of RAM that'll set you back around $3K."

If you're looking for something a little more powerful you can upgrade those processors to an AMD Ryzen 9 6900HS CPU and a Radeon RX6800S GPU with 32GB of RAM for $3,499. While it would seem like you should be able to get the same FullHD+, 144Hz or QHD+, 120Hz display option here, we could only actually find the QHD+ option with the RX6800S in local stores.

Intel's 12th generation processors have improved significantly in the last generation, so even though the Ryzen 9 6900HS is ahead of the Ryzen 9 5900HS, it's up to 30 percent behind the average device running an Intel Core i7-12700H, in some benchmarks. This difference is less dramatic in other work tasks, catching up to operate within 10 percent at times, but that's still a pretty convincing performance lead by Intel. The difference unfortunately means laptops like the ROG Zephyrus G14 will be a bit behind in general computing tasks, but there is a silver lining. The Ryzen 9 has upped its boost clock speed to 4.9GHz, which means it should perform better in gaming tasks now that its single-thread CPU capabilities are in line with Intel's.

■ W11 Home; 14-inch 120Hz IPS display at 2560 x 1600 pixel resolution; Full DCI-P3 Colour; AMD Ryzen 9 6900HS CPU; AMD Radeon RX6800S GPU; 32GB RAM; 1TB PCIe SSD; 70wh battery (6h 30min 1080p movie playback); 31.2x22.7x1.95cm; 1.72kg.

Asus is claiming noteworthy improvements in gaming performance since swapping from the Nvidia GeForce RTX 3060, with gaming performance improvements of up to 40 percent on the RX6800S and 20-30 percent on the 6700S. We weren't able to replicate those performance bumps with our RX6800S test unit, getting closer to just half that improvement figure, but that still puts it above the 3060 sitting roughly 10 percent behind a 120W 3070 Ti. This translates to 70+ fps on your average Triple-A title running at 1080p Ultra settings. If you do opt for the 6700S GPU, that framerate average will be closer to 60+fps using the same settings.

For anyone that opts for the 14-inch 2560 x1600 pixel display, it comes with a Pantone validated colour profile so you can work professionally on it. With a six hour battery life for light workloads it's way better than your average gaming machine, and while it comes with a standard power brick, you can alternatively charge it using USB-C if you're in a bind.

	Asus ROG Zephyrus G14 (6900HS, RX6800S)	Asus ROG Zephyrus m16 (i9-12900H, 3070 Ti)
PCMark 10 - Overall (score)	7,380	7,208
Geekbench 5 - Multi-core (score)	9,757	10,954
3DMark - Time Spy (score)	8,711	9,528
The Division 2 - Ultra 1080p (fps)	73	84
PCMark 10 Battery - Modern Office (h:min)	06:07	02:55
Peak CPU temperature (°C)	99	100
CrystalDiskMark Read (MB/s)	3,645	7,089
CrystalDiskMark Write (MB/s)	3,482	5,285

A powerful gaming ultraportable that lights up for both work and play.

Joel Burgess

★★★★★

GAMING LAPTOP

Dell G15

Dell's budget gaming mainstay is pushing up its performance, but does this create a price problem?

■ $3,299 | dell.com/en-au

■ W11 Home; 15.6-inch 165Hz IPS display at 1920 x 1080p resolution; Intel Core i7-12700H CPU; Nvidia GeForce RTX 3070Ti (140W); 512GB SSD; 78.5Wh battery (1h38min 1080p movie playback); 35.7x27.2x2.7cm; 2.7kg.

Dell's G15 gaming laptops have been a staple in the more affordable gaming laptop space for years now, but with a range that offers GPUs up to a Nvidia GeForce 3070 Ti, these units are playing in the high performance gaming laptop space too. Because there's quite a span here the devices at one end are a bit of a different beast to ones at the other. Take for example the entry level $1,999 ($1,699 on sale) G15 which comes with an Intel Core i5-12500H CPU, a Nvidia 3050 GPU and a 15.6-inch 120Hz Full HD screen. At 2.7cm thick, it's a chunky device that is way thicker than it needs to be considering the GPU power you'll get from it. On sale it's roughly the same price as the handful of other devices with comparable specs although if you're open to even more entry level graphics you can still nab alternative devices with 1650 GPUs for $600 less.

The G15 that we got in to review comes with an Intel Core i7- 12700H CPU, a 3070 Ti GPU and a 15.6-inch 165Hz Full HD screen for $3,299. While the G15 is still pretty thick against competitors, at this end the extra girth means the GPU can use up to 140W of power to really push the performance. It's not the highest wattage we've seen on a mobile 3070 Ti, but it is within seven percent of the performance of the $3,849 150W 3070 Ti MSI Raider GE76. This translates to 100+ fps on modern games running 1080p ultra settings and can even get close to 60 fps averages running ray tracing on 1080p Ultra without supersampling.

In terms of general work performance you can expect the G15 to be between 10 and 50 percent better than last year's configurations, depending on the task. There was a big shift in the chip structure between these generations so some tasks will see bigger jumps than others but it's a big improvement across the board and you won't get much better performance on a laptop ulness you look to specialised workstations.

> "In terms of general work performance you can expect the G15 to be between 10 and 50 percent better than last year's configurations, depending on the task."

In addition to being bulky, the G15 also has pretty dismal battery life, much like the standard gaming laptops of yesteryear lasting just a little over two hours in work benchmarks and even less for movie playback.

The G15 range offers pretty modest gaming screens compared to the 300Hz and even 480Hz you can get on some competitors these days. The entry 120Hz screen has a maximum 250 nit peak brightness and even the more premium 165Hz display is only 300nit, which is fine in a dark room, but only just. That said, when you consider the top spec unit here doesn't push above 124fps, even in less demanding games at 1080p Ultra, there's an argument to be made for not needing more than 165Hz on anything but the most premium gaming laptops. As a result the G15 is $550 cheaper than a similarly specced MSI GE76.

The keyboard and trackpad are pretty stock standard and while it's bulky the overall design isn't offensive.

	Dell G15	MSI Raider GE76
PCMark 10 - Overall (score)	7,294	7,618
Max CPU Temperature (C)	99	99
1080p movie playback (HH:MM)	01:38	06:06
Cinebench R23 - CPU (Score)	16,125	17,118
3DMark Time Spy (score)	10,879	11,247
The Division 2 - 1080p Ultra (fps Av.)	105	102
CrystalDiskMark Read(MB/s)	3,102	6,584
CrystalDiskMark Write (MB/s)	1,884	5,085

A no frills, high performance gaming laptop that cuts costs in reasonable areas.

Joel Burgess

★★★★☆

ULTRAPORTABLE LAPTOP

Acer Swift 5

Acer is looking to push into the premium ultraportable space with the 2022 Swift 5, but has it arrived a little undergunned?

■ $2,899 | acer.com

Acer's range of professional ultraportable laptops have been some of *APC*'s top rated devices over the last few years, primarily because they offered excellent performance in a package that you wouldn't obviously distinguish from the top end devices even though it cost hundreds (sometimes thousands) less. This doesn't seem to be the direction Acer has taken the 2022 Swift 5 in. Whether it's the CNC-machined aluminium chassis with anodised gold trim, the OceanGlass touchpad and fingerprint reader, or the 12-core 12th Gen Intel processor , it's clear that this year's Swift 5 is trying to compete with Apple, Dell and Microsoft for the most desirable premium professional ultrabook around.

By throwing its hat in the ultra-premium ring, it's no surprise that the 2022 Swift 5 is $500 more expensive than its predecessor at launch, landing at $2,899. For this you'll get a 14-inch 1920 x 1200 pixel display, an Intel i7-1260P CPU and 16GB of RAM. Intel's 12th Gen CPUs have quite a few changes and are understandably more expensive, but when you can get a Dell XPS 13 Plus with similar components and a 4K screen on sale for less than the Swift 5, there's going to need to be some pretty impressive features to get anyone over the line.

Acer has spent a bit of effort ensuring the Swift 5 has adequate cooling, and it's invested in decent AI background noise reduction software for its dual microphone and 1080p web conferencing package. Other than this, the only other noteworthy bonus is the DTS audio tuning. There's no discrete GPU, no professional level screen colour calibration. The Swift 5 doesn't have a customisable touch bar or an ultra sensitive stylus. There's no second screen, or convertible hinge. There's no OLED, 4K or even a QHD display, and it's not running a custom processor with a different OS. In short it's missing basically all of the drawcards of its competitors, but is priced similarly.

■ W11 Home; 14-inch IPS display at 1920 x 1200 pixel resolution; Intel Core i7-1260P CPU; 16GB RAM; Intel Iris Xe Graphics; 1TB SSD; 56Wh battery (10h17min 1080p movie playback); 31.1x21.3x1.5cm; 1.2kg.

> "The battery life has been improved, offering over 11 hours in work benchmarks and over 10 hours of 1080p movie playback."

There are, at least, some redeeming features of the Swift 5. The battery life has been improved, offering over 11 hours in work benchmarks and over 10 hours of 1080p movie playback. It's also more powerful thanks to the addition of eight Atom cores that compliment the four performance cores allowing the device to double its performance over the last Swift 5 in certain benchmarks. Graphically the improvements are more modest landing at around 20 percent for synthetic benchmarks. This puts it on par with what you'd expect from a device running an i7-1260P, which means a lot of the credit goes to Intel rather than Acer.

If you're really searching for reasons to buy this device then you could look to the keyboard, which is reasonably nice to type on, and there's a full size HDMI port to connect displays to. There's also no major red flags that'd stop you from buying it, so the only things holding it back are price and bonus features. Unfortunately in the ultra competitive premium Ultraportable space, that's the difference between something standout and something mediocre.

	Acer Swift 5	Dell XPS 13 Plus
PCMark 10 - Overall (score)	5,162	5,125
Geekbench 5 - Multi-core (score)	9,401	8,594
Cinebench R23 - CPU (multi-threaded)	8,048	8,161
3DMark - Time Spy (score)	1,962	1853
Battery life - 1080p video playback (h:min)	10h17min	6h6min
Peak CPU temperature (ºC)	95	100
CrystalDiskMark Read/Write (MB/s)	6,903	7,082
CrystalDiskMark Read/Write (MB/s)	5,176	5,095

A sleek, powerful ultraportable with a good battery, that's short on features.

Joel Burgess

★★★☆☆

MONITOR

Acer Predator XB323QK

32 inches of fantastic 4K 144Hz action.

■ $1,349 | www.acer.com

■ Native resolution: 4K (3840x2160); Refresh Rate: 144Hz; Panel technology: IPS; Response time: 1ms; Aspect ratio: 16:9; Inputs: 2x HDMI 2.1, DisplayPort 1.4, USB-C: Display features: AMD Freesync, Nvidia G-sync: Contrast ratio: 100,000,000:1; Dimensions: 71.6 x 30.9 x 53.4cm; Weight: 13.5kg.

The thing with luxuries is that, once you've experienced them, it can be difficult to go back to the mundane. This monitor has everything going for it. It's a 4K display with an IPS panel, a huge 32-inch screen, a 144Hz refresh rate, and support for both AMD FreeSync and Nvidia G-sync. Those stats make it a dream monitor for gamers, offering the most premium of experiences short of an 8K television or an OLED monitor.

The Predator XB323QK also has lots of worthwhile extras and features, including two HDMI 2.1 ports, allowing you to connect both an Xbox Series X and PlayStation 5 simultaneously while taking advantage of their 4K 120Hz variable refresh rate signals. There's also a USB-C port with 65W power delivery, meaning you can connect a laptop and power it at the same time.

It also has configurable RGB lighting on the rear for that pro gamer look, built-in speakers, a headphone jack, and two USB-A ports next to its video inputs. Sadly, these are located on the underside of the body and are rather fiddly to access.

Thankfully, the monitor's performance is as impressive as its feature set. Picture quality in games is stunning thanks to a display that boasts fantastic detail and great responsiveness. Colours aren't the most vibrant, but this can be alleviated by digging into the monitor's on-screen setup and tweaking the settings.

Gamers are also covered thanks to dual compatibility with AMD FreeSync and Nvidia G-sync and, combined with the 144Hz refresh rate, games driven by a suitably powerful GPU look stunning on this screen. Similarly, console owners will be able to get the best out of their machines on the Predator XB323QK thanks to the two HDMI 2.1 ports.

The screen's rated brightness of 400 nits is standard for gaming monitors and bright enough for most uses, including work and gaming. The 90 percent DCI-P3 colour space rating will be good enough for most, although content creators may want to invest in something better.

The metallic stand feels sturdy, which is important for this heavy 13.5kg monitor. The stand allows you to move the screen up and down as well as tilt it 30°, but you can also VESA mount it if you wish. It's rare for a monitor to have built-in speakers, and though they go loud, they start to sound rather tinny at over 30 percent volume, so make sure you have some change for a decent set of speakers or headphones. Similarly, the 65W USB-C power delivery may not be sufficient to power many of the gaming laptops that will be used to drive this monitor.

The Predator XB323QK is pricey thanks to its 4K display, but it very much delivers for those looking to push their high-end GPU to the max. Support for both FreeSync and G-Sync means it will be compatible no matter what GPU you buy in future, while a generous set of connections make this the ideal monitor for someone who uses desktops, laptops, and consoles for gaming. If you have the desk space and a beefy PC, it's a fantastic 4K gaming monitor

4K 144Hz display, USB-C and HDMI inputs, plus FreeSync and G-sync. But it's expensive, and has substandard speakers.

Guy Cocker

★★★★☆

MONITOR

HP X34

Great value ultrawide for gamers.

■ $520 | www.hp.com

■ Native resolution: WQHD (3440x1440); Panel technology: IPS; Response time: 1ms; Aspect ratio: 21:9; Inputs: HDMI 2.0, DisplayPort 1.4; Display features: AMD Freesync Premium, G-sync Compatible; Contrast ratio: 1000:1; Dimensions: 81.65 x 5.36 x 36.81cm; Weight: 8kg.

Ask a gamer to describe their ideal gaming monitor, and they're likely to say "4K". The problem, of course, is that driving a 4K monitor requires a high-end graphics card that can add a significant amount to your budget. For most, a realistic sweet spot is a 1440p monitor that can be driven by a more modest GPU.

HP's X34 appears to hit this sweet spot while offering lots of additional features for a reasonable price. The headline feature is its 34-inch ultrawide display with a large amount of screen real estate. It also has a high 165Hz refresh rate and has a 1ms response time. All great things to have on a monitor not much over $500.

The X34 makes a good first impression, with thin bezels along the side and top, and a small centralized base. Mounted on the included stand, the monitor is height adjustable and tiltable. It can't be rotated 90 degrees, but can be mounted on a standard VESA 100mm x 100mm bracket.

Connectivity is where things fall down slightly, with just one DisplayPort 1.4 and one HDMI 2.0 connection. That's not much if you want to hook up multiple PCs and game consoles. And while it's all good on the PC side, console gamers may have preferred the newer HDMI 2.1 standard. While the PlayStation 5's new variable refresh rate mode is supposed to require it, we found it worked fine at 1080p on this monitor, so it's not a major issue. There's also a 3.5mm headphone jack for those using wired headphones. The other big omission is there are no USB ports on this monitor, but that's probably something gamers can live without.

In terms of performance, this is a dependable monitor that delivers everything gamers need. The IPS panel offers excellent viewing angles, superb colour accuracy, and great contrast, and combined with the ultrawide format, offers an immersive experience. The use of IPS also helps response times, which go as low as 1ms if you enable it in the monitor's settings. Like nearly all gaming monitors aside from the latest OLEDs, HDR performance is nothing special, but it's there if you want to enable it in more cinematic titles.

Like the 1440p resolution, the 165Hz refresh rate sits in the sweet spot for gamers – more than fast enough for anyone except eSports players. There's support for AMD FreeSync Premium, the middle tier of AMD's variable refresh rate standards, and we also found the monitor supports G-sync, though it's not officially listed as such. That means this is a great option for gamers no matter what GPU they're rocking, and we enjoyed a smooth tear-free gaming experience from our RTX 3070Ti.

While the X34 is marketed primarily as a gaming monitor, content creators may also appreciate the 99 percent sRGB colour space rating. Working on the X34 also feels efficient due to the ultrawide format, making this an excellent all-round desktop monitor.

There's something reassuring about a monitor that nails the basics as well as the HP X34 does. It offers all the features that most gamers need and delivers an excellent picture at a compelling price point.

A large 34-inch display with 165Hz FreeSync and G-sync and thin bezels, but limited video inputs and no USB ports.

Guy Cocker

★★★★☆

COOLING

Be Quiet Pure Loop 2 FX

More than just a Pure Loop 2 with RGB bolted on.

■ $180 | www.bequiet.com

On the opposite page is our review of Be Quiet's Pure Rock 2 FX CPU cooler. We're fans! Pun intended. Now we come to our second Be Quiet cooler review. This time it's an all-in-one liquid cooler. Can this 280mm AIO impress us as much as its air-cooled stablemate did?

As is the case with the Pure Rock 2 FX, and other Be Quiet products, the Pure Loop 2 FX is designed to operate quietly. Having tested the non RGB version a year or so back, I found that to be the case, but Be Quiet put a little too much emphasis on the low noise levels, and its cooling performance suffered as a result. This time, Be Quiet has included higher speed Light Wings 140mm fans, and I hope this provides a better balance between cooling capability and low noise performance.

For review, we have the 280mm Be Quiet Pure Loop 2 FX. 280mm is a good and perhaps underrepresented form factor. They perform better than 240mm coolers but don't necessarily require a large case like a 360mm cooler would. Do be aware that not all cases will accept a 280mm cooler though. Check to make sure your case will house it.

> "Be Quiet put a little too much emphasis on the low noise levels, and its cooling performance suffered as a result."

■ Be Quiet! Pure Loop 2 FX 280mm AIO liquid CPU cooler; 400mm Tubes; AMD AM5, AM4, Intel LGA 1700, 1200, 115x, 2011(3) & 2066 compatible; 2x Light Wings 140mm PWM high-speed ARGB fans; max 31dB(A) Noise Level.

Personally, I believe the Pure Rock 2 FX looks great. The bundled Light Wings fans with their ARGB rings look great in a darkened tempered glass case like our Razer Tomahawk. Even the head unit looks good with its brushed aluminium face and subtle ARGB ring. Be Quiet includes a six channel ARGB controller for complete system integration, that's a nice value add right there.

The pump integration is a little different from what you normally might see. Rather than mount it in the head, Be Quiet has it mounted in-line, adjacent to the radiator. This helps to lower vibrations. mounting the head onto our test system was quick and easy.

The Light Wings 140mm fans are the high-speed variety. That's important as it addresses our concern with the older Pure Loop 2. The Pure Loop 2 FX is no longer a one trick low noise cooler, it can match a good quality 360mm unit both in terms of noise levels and thermal performance. Be Quiet deserves a shout!

Do note that under load, the cooler is not silent, and honestly, it's impossible to expect silence when using a modern high TDP processor, but under a general gaming load, the noise of the GPU fans was easily more noticeable than those of the Pure Loop 2. The pump was quiet too, with none of that annoying whine that you can hear with some pumps.

At $180, the Pure Loop 2 isn't cheap, but it ends up around the price of the Corsair iCue H115 RGB. That may prove to be its main competitor. We feel that Be Quiet has nailed the Pure Loop 2 FX. It looks great and it strikes a great balance of good cooling capability without losing sight of Be Quiet's core mission of delivering low noise levels. Add to that, you get an ARGB hub and a competitive $180 price and we've got ourselves a new favourite 280mm AIO cooler.

The Pure Loop 2 FX is a step up from the non FX version. It looks and performs better while not losing sight of the goal of quiet operation.

Chris Szewczyk

★★★★½

Be Quiet! Pure Rock 2 FX

Yes, Be Quiet goes RGB!

■ $68 | www.bequiet.com

■ Be Quiet! Pure Rock 2 FX CPU cooler; up to 150W TDP cooling capability; AMD AM5, AM4 & Intel 1700, 1200, 2066, 1150, 1151, 1155 and 2011(-3) compatible; 1x Light Wings 120mm PWM fan; max 24.4 dB(A) noise level; 3 Year Warranty.

There's no doubt that AIO liquid cooling is becoming nearly essential to keep high TDP processors cool. But we can't forget there are a lot of 65W class CPUs out there that simply don't require an expensive liquid cooler. Air cooling is here to stay!

The Be Quiet Pure Rock 2 FX is an affordable single tower cooler that can dissipate up to 150W, which means that any recent non-K Intel CPU and all AM4 CPUs are within the capabilities of the Pure Rock 2 FX.

German manufacturer Be Quiet's cooling products usually perform well in these pages. As you'd guess by the name, its cases and coolers are designed with quiet computing in mind, and who out there doesn't appreciate that? But Be Quiet isn't ignoring the evolving PC market. RGB is here to stay, and though you may love or loathe it, it's good to have the option. You can always turn it off!

> "Its lovely black design will blend in with just about every modern build."

The Pure Rock 2 FX is an evolution of the company's Pure Rock 2 cooler. Its lovely black design will blend in with just about every modern build. It includes Be Quiet's new Light Wings RGB fan. We use a Razer Tomahawk ATX case for cooler testing, and personally, I think the ring RGB fan looks fantastic through the Tomahawks darkened tempered glass side panel.

The bundled Light Wings fan is a 120mm PWM model with an ARGB ring. Even though Be Quiet has gone over to the light side, it still remains all but silent under general operation. Like any cooler, it will spin up and become audible under full load but it never reaches an intrusive level. Much like other Be Quiet fans we've tested over the years, it's a favourite of ours.

As a mid-2022 release, socket compatibility has been updated. LGA 1700 support is expected, and it also lists AM5 support. Of course, it's expected that all AM4 coolers are AM5 compatible, but this specific confirmation will be useful to some buyers who may not be clear on that point.

The installation of most air coolers is pretty straightforward these days. About the only niggle relates to the fan retention clips which could prove to be fiddly in a compact case. Also note you'll need to plug the fan into an ARGB header or controller to sync it up with the rest of your system.

We tested the Pure Rock 2 FX with an AMD Ryzen 7 5800X CPU. Even with PBO enabled, it's within the capabilities of the Pure Rock's TDP rating. A 5950X or 12900K will be beyond it. The Tomahawk ATX is not a high airflow case which means that CPU temperatures will be higher than those of an open mesh design. A long period load temperature of 72c during loops of Cinebench is impressive. Remember we're talking about a $68 CPU cooler here. Very good!

Be Quiet usually delivers the goods and the Pure Rock 2 FX is another impressive offering from the German manufacturer. Don't expect to run an overclocked 12900K with it, but with the right choice of a 65W class CPU it will perform very well (and look good doing it). Add to that an affordable price and reliable air cooler operation and the Pure Rock FX is an easy recommendation.

The competition is tough at this price, but if you pick the Be Quiet Pure Rock 2 FX, you won't be disappointed.

Chris Szewczyk

★★★★½

SMARTPHONE

Google Pixel 6a

A one-hand-holdable 6.1-inch phone that's pure Android that ticks almost all the boxes.

■ $749 | store.google.com

■ 8-core Google Tensor processor; 6GB RAM; Mali-G78 graphics; 6.1in 60Hz AMOLED screen, 1,080 x 2,400 resolution; 5G; 128GB storage; IP67 rating; dual 12.2MP/12MP rear cameras; 8MP front camera; Wi-Fi 6E; Bluetooth 5.2; NFC; 4,410mAh battery; USB-C connector; Android 12; 72 x 8.9 x 152mm (WDH); 178g; 1yr warranty.

Another new Google phone? Well, sort of. Arriving nine months after the rest of the Pixel 6 family, the 6a is positioned as an affordable alternative to the original phone, rather than a real update. The 6a has a few attractions besides price: with a smaller frame and weighing just 179g, the 6a is more comfortable to use in one hand.

The 6a's plastic rear feels cheaper than the glass of its siblings, even if it's less likely to shatter when dropped. The phone also lacks a headphone jack socket – a shame, since that was a big selling point of last year's 5a. And while the screen has the same 1,080 x 2,400 resolution, it uses a bog-standard 60Hz refresh rate rather than the 90Hz of the Pixel 6.

It's a similar story round the back. Where the Pixel 6 and 6 Pro have top-quality 50-megapixel main cameras, the 6a's primary camera has only a 12.2-megapixel sensor, which means photos come out with less detail and clarity. There's a 12-megapixel ultra-wide camera too, but no telephoto lens or optical zoom.

This doesn't mean you can't get good results from the 6a, as it still benefits from Google's AI- based optimisations. These help even out the exposure and colour balance of your photos, and you also get the celebrated Magic Eraser tool that can seamlessly remove unwanted elements from your shots.

> "The 6a has a few attractions besides price: with a smaller frame and weighing just 179g, the 6a is more comfortable to use in one hand."

One area where the Pixel 6a isn't cut down at all is the CPU: it uses the same Tensor chipset as Google's full-fat Pixel 6 phones. This isn't the fastest processor on the market, but it outpaces most mid-range phones. In use I found the phone perfectly snappy for navigation and most tasks, helped along by 6GB of RAM.

One of the big selling points of Pixel phones is that they run absolutely clean Android, with no third-party customisations. So it is with the Pixel 6a: it comes with all the standard Google apps such as Gmail, Photos, the Play Store and Maps, but beyond that there's zero in the way of pre-installed bloatware.

There's only one area where the Pixel 6a really falls down, and that's battery life. I found the phone often struggled to get through a full day of typical use, even with battery saver mode active the whole time. Hardcore gaming, video recording and the like will reduce longevity further.

This isn't just disappointing – it's perplexing. The 6a's 4,410mAh battery has very nearly the same capacity as the one in the Pixel 6, which happily got me through a full day of use. That suggests that perhaps some future software optimisation could extend the 6a's battery life. Don't bank on it, though.

That disappointing performance hurts the Pixel 6a. It's a shame, because we love the idea of a pure Google phone with a compact case and a low price. If Google, or the community, can fix the battery issue then this is comfortably a four star phone.

The same powerful processor as its premium sibling, in a perfectly-sized 6.1-inch body that many people prefer to giant slabs.

Tom Bedford & Ben Mansill

★★★☆☆

MONITOR

Prism+ C315 Max

Meet the Prism C315 Max, from one of AU's growing monitor brands.

■ $459 | www.prismplus.com.au

■ Prism+ C315 Max LCD Monitor; 31.5-inch; 3840x2160 resolution; 350nit peak brightness; 60Hz refresh rate; HDR400; 4ms (GTG) response time; Vertical Alignment (VA) panel; 1500R curvature; FreeSync compatible; 1x DP 1.2, 1x HDMI 2.0, 2x HDMI 1.4; Three-year warranty.

The monitor market is a crowded one. There are dozens of brands to choose from. One of the lesser known names in the Australian market is Prism+. Though the name might be a new one to many Australian readers, the specs of some Prism monitors are a match for anything on the market.

Prism sent over its C315 Max for review. It's a 31.5-inch curved VA monitor with a 4K resolution. Prism is targeting productivity-oriented users with the C315 Max. As it's a 60Hz panel with a 4ms GTG response time, that would bear out, though it does have Freesync support so it will moonlight as a gaming screen after hours.

Assembling the unit is straightforward. You remove the small back panel, attach the base to it and then click it back on. The downside is that you only get tilt support. Height adjustment would be nice, but it's far from a deal breaker and I didn't feel the need to adjust it to suit my sitting position anyway. You also get 75mm x 75mm VESA support.

There are no less than four display inputs though two of them are HDMI 1.4, which limits them to 30Hz at 4K. Definitely use the HDMI 2.0 or DP 1.2 port instead. The C315 Max doesn't include speakers or USB hub functionality, presumably to keep costs down.

The image is clear and sharp, as you'd expect from a 4K panel. The extra screen size makes a big difference when it comes to productivity. I was able to set the monitor to 100 percent scale at a normal viewing distance. That's something I can't do with my current 27-inch 4K screen. Size matters!

As the C315 Max uses a VA panel, the contrast is good. Blacks appear black, though in a dark environment, some backlight bleeding becomes evident. It only really shows up when doing something like watching a 21:9 video where there are black bars at the top.

Out of the box it's extremely bright, but dropping it to 50 percent brightness solved that. Prism claims the monitor supports 120 percent sRGB. The colours do appear bright and contrasting but they lack a little bit of the vibrancy that you'd expect from a high quality IPS panel. However, it's much better than my ageing TN 4K screen which looks decidedly washed out in comparison.

The C315 Max is best used as a general-purpose monitor. A content creator demanding the best colour accuracy will be better served by an IPS monitor and/or a flat panel. As a screen that allows you to have multiple windows open, a curved 4K 31.5-inch feels like a very good sweet spot. As a work-from-homer. Having one on my desk for a week or so was a happy experience. Two side by side would be even better, especially with the thin bezels.

The C315 Max doesn't particularly reinvent the wheel. It does a good job without really standing out. At the time of writing it was available for just $459, and at that price it's a bargain for what you get. If gaming isn't your priority and you work from home, spending a lot of time looking at your screen, the C315 Max is a competitive option and it provides us with a good introduction to the Prism brand.

The Prism C315 max is a competent 4K curved screen, though there is tough competition in this part of the market.

Chris Szewczyk

★★★★☆

NAS

Synology DiskStation DS1522+ NAS

Synology's new 5-bay drive arrives with a new generation of home/SMB internals. But, there are caveats.

■ $1,199 | https://www.synology.com/en-au

■ 3.1GHz dual-core Ryzen R1600 CPU, 8GB DDR4 ECC RAM (expandable to 32GB). 5 x lockable 3.5-inch drive bays, 2 x NVMe M.2 drive bays, 2 x eSATA, 2 x USB-A 3.3 Gen 1, 4 x 1Gb Ethernet ports, PCIe x8 slot, Synology DiskStation Manager operating system.

Synology has finally released its long-awaited five-bay drive. This is a size that's considered a sweet spot for enthusiasts thanks to its ability to start-off with a high capacity yet provide some future-proofing headroom. However, a few design decisions have raised eyebrows, so is it the desirable NAS that we hoped it would be?

But, first let's remind ourselves of the ease of set-up. Even if you've never touched a NAS, it's hard to see how populating the drives and formatting them could be any simpler. You simply flip open the (lockable) hot-swap drive bays, insert the drives into cages with their quick-fit, tool-less, rubber-grommet-dampened design (you can screw them in for added rigidity), plug the device into your router and turn it on. From this point you can use a phone app or your computer to quickly locate, and format it then be up and running about 10 minutes later.

It's worth remembering that Synology only allows approved hard drives to be used in its modern devices and, while the compatibility list is still missing some obvious options from major players, it doesn't feel as limiting as when first announced. All typical multi-disk RAID options are available but we prefer Synology's own SHR format which provides proven performance, robustness and, unlike other RAID arrays, lets you add drives with different capacities.

Beyond the drive-bay count, the specific technology differences (which we'll likely see on future drives of the same generation) include the move from a Celeron quad-core processor (with integrated GPU) to a dual-core, four-thread, 3.1GHz AMD Ryzen CPU. While the clock-speed is faster, those who transcode video regularly may have wanted more.

There are two SODIMM RAM slots inside the drive and a generous, 8GB ECC module takes up one. If you need more (for memory-hungry apps like Surveillance Station) it supports up to 32GB.

There's a USB-A 3.2 Gen 1 port at both front and back for removable storage, extra networking dongles and even UPS. But, some will be annoyed at the lack of USB-C 3.2 Gen 2 with its superior speeds and proliferating connector.

There are four, Gigabit Ethernet ports which may disappoint those wanting 2.5GbE (which features on many modern routers, including Synology's own). However, this is countered by a new 10GbE upgrade slot. While the ($259) card is proprietary, it's simple to install unlike previous PCIe-based iterations which required the chassis to be almost-completely dismantled.

At the base are two, NVMe drive bays. While these can only be used for caching (not storage) it's worth remembering that the DSM 7 OS makes good use of Read/Write caching nowadays.

Under load, the two fans rarely rose above a quiet, unobtrusive whoosh. While we couldn't cause a transcoding slowdown, hardcore multimedia buffs might feel limited – now or in the future. But that's the only downside, the best part is the DSM software which offers excellent license-free apps for all consumer, SMB and Enterprise storage, back-up and server requirements. At $1,199 it's not cheap but factoring in the software means it's great value.

Though some internal silicon may lack headroom, this is still a well-featured, expandable NAS with fantastic software.

Nick Ross

★★★★★

GAMING MOUSE

ASUS ROG CHAKRAM X

More of a Veyron than a 911.

■ $269 | rog.asus.com

If there are any true mouse *enthusiasts* out there, then this is the rodent for you. This luxo-beast packs in everything you can think of, and more. The specs are ridiculous – the optical sensor can handle up to 36,000 DPI and a polling rate of up to 8,000Hz when connected via USB-C. That's crazy numbers territory, and imbues the Chakram X with unmatched smooth precision.

Wireless comes in either 2.4GHz or Bluetooth flavours, and you can expect around 150 hours per charge with the RGB effects off, but in testing it looked so damn fine at night we felt the need to keep it on. Wireless Qi charging is supported. The only downside is it needs the Armoury Crate app for full functionality, which is our least favourite Asus product.

There are swappable switches, and the box comes with spares. Mouse switches are a standard part and they're extremely cheap, making this one so easy to customise. The switches it came with were perfectly fine to me.

> "The specs are ridiculous – the optical sensor can handle up to 36,000 DPI and a polling rate of up to 8,000Hz when connected via USB-C."

There is a joystick button on the side for your thumb, for a total of 11 programmable buttons. Excessive, moi? I personally didn't get a lot of use from the joystick, and it can be covered up to get out of the way if you're the same. Super hardcore gamers will find a use for it, I'm sure.

It felt a tiny bit on the heavy side (127g) for fast flicking in a FPS, but this isn't a dedicated esports weapon – it's a Bugatti Veyron, so that means a little heft.

Yes, it's expensive, but this is upper echelon gear here and all these features command a price.

Ben Mansill

★★★★½

KEYBOARD & MOUSE

LOGITECH SIGNATURE MK650 COMBO

A no frills set for business buyers.

■ $TBC | www.logitech.com

Logitech's MX series shows that it knows how to build high-end keyboards and mice, but the mid-range MK650 Combo has different ambitions. Here, Logitech targets IT managers equipping offices and hybrid workers with a simple and modern keyboard and mouse set.

Logitech's promise is that this set will last for years and shouldn't bring in any support calls. Plug in the USB Bolt receiver, or connect through Bluetooth, and it just works. That's true whether on a Windows PC, Mac, iPad or even Linux and ChromeOS systems.

> "Logitech's promise is that this set will last for years and shouldn't bring in any support calls."

The keyboard is nothing special. The keys lack the cushioned feel of the MX Keys family and are quite loud, too. There's no backlight, and Logitech has been stingy with the LEDs: one for Caps Lock, one for the pairing button, and one that will flash red when the battery is low – but according to Logitech that will be after three years. The mouse is better, with a contoured shape that fits nicely in the hand. And while it's not a travel mouse, it's so compact that I would be happy to sling it into my bag. Right-handers will find that the two side-mounted shortcut buttons sit perfectly under your thumb, while the speedy scroll wheel is a cut above those cheap Amazon mice.

Will the MK650 save you money in the long run? If it stops even one support ticket over the course of this device's life then arguably yes, and you can certainly trust Logitech to build a more reliable keyboard and mouse than the cut-price offerings elsewhere.

Dependable Logitech quality and design aimed at equipping office workers.

Tim Danton

★★★★☆

Windows 10 or 11, macOS or Linux | FREE | calibre-ebook.com

CALIBRE 6.1

Crap be gone!

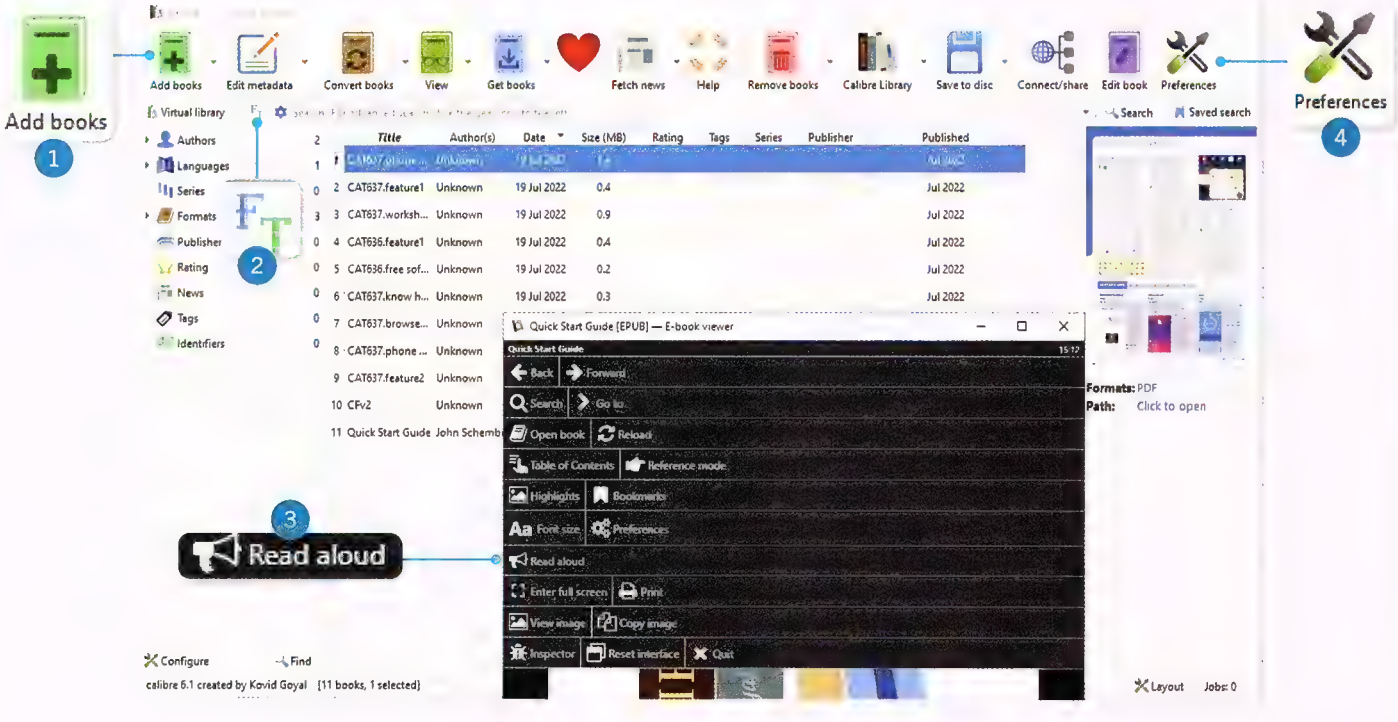
This brilliant open-source program is the best way to read and manage ebooks on your computer without being tied to a single service such as Amazon's Kindle Store. It lets you convert ebooks easily from one format to another, edit their contents, download articles from the web, back up and share your library, and much more.

Calibre 6 is the first big update for a year-and-a-half (the 6.1 refers to a few bug fixes implemented shortly after its release) and somehow finds space for even more features without making the interface overcrowded. The most significant is a full-text search tool, which indexes all the ebooks in your collection, so you can quickly find mentions of specific names, words and phrases. Before you can use this feature, you must click the FT icon on the left-hand side of the search bar to enable the indexing option. When you add new books, Calibre will index them automatically in the background.

Another welcome addition is a 'Read aloud' function in Calibre's ebook viewer, which in effect converts text into an audiobook. Select a book and click View to open the viewer - or just press V on your keyboard - then right-click and choose 'Read aloud'. You can then use controls in the top-right corner to slow down, speed up and pause playback and change the voice – Calibre uses your operating system's own text-to-speech options. We also like the new dark mode, which protects your eyes while you're reading at night. Turn this on by going to Preferences, 'Look & feel'.

The program syncs with virtually all models of e-reader, so you can transfer books between devices, either wirelessly or using a cable, and carry on reading where you left off. It even detects and converts to the best ebook format for your reader. However, as of this version, Calibre has dropped support for Windows 8 and 32bit systems.

"Another welcome addition is a 'Read aloud' function in Calibre's ebook viewer, which in effect converts text into an audiobook."



1 Click the 'Add books' button to import books into Calibre. The program supports all ebook formats, including EPUB, HTML, MOBI, PDF and Amazon's AZW, and lets you convert files from one format to another.

2 To enable Calibre's full-text search feature, click the FT icon in the address bar and select 'Index books in this library to allow searching their full text'. To use it, click 'Start searching' and type the term you want to find.

3 Select a book in the main pane and click View to open it in Calibre's ebook viewer. You can then right-click and choose 'Read aloud' to turn the book into an audiobook using the new text-to-speech tool.

4 You can switch on Calibre's dark mode to reduce the risk of eye strain while you're reading ebooks at night. Click 'Preferences' then 'Look & feel', select Dark in the 'Color palette' menu and click Apply.

iOS 14.5 or later | Free (IAPs) | tiimoapp.com

TIIMO – VISUAL DAILY PLANNER

A new way to plan your day?

There are plenty of day planner apps out there, but few that are made for neurodiverse users with conditions ranging from autism to ADHD. Tiimo aims to fill that niche.

That's not to say you can't use it if your needs are different. The app will appeal to more or less anyone who is looking for an app to help them organise their day, and there are few hints that it was made to be a particularly specialised app. The considerations made for its target audience – mainly its focus on visual planning – can be appreciated by anyone.

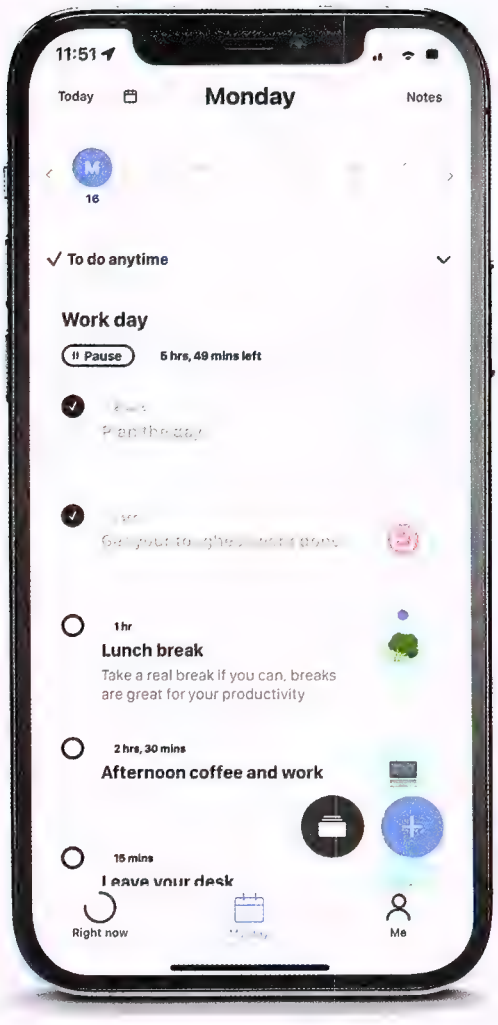
> "The app will appeal to more or less anyone who is looking for an app to help them organise their day."

So, what's it like to use? For the most part, it's a pleasing experience. The main My Day tab has a horizontal calendar at the top and a vertical timeline below, so scrolling through your day is simple. You can add activities or entire pre-made routines to the timeline, and each item can be assigned an icon and a colour, and set to repeat on a customisable schedule. When you allocate a time to an item, you see a progress bar as it gets underway, while the Right Now tab shows your progress on the currently active task.

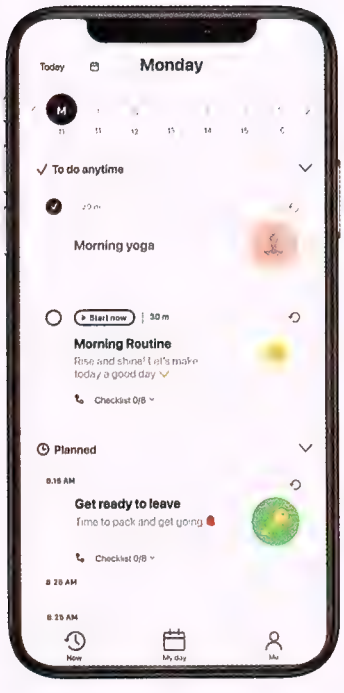
In other ways, though, Tiimo is a mixed bag. There are plenty of good ideas here, and the emphasis on visuals is definitely the app's strong point. But it lacks the polish needed to make it a true must-have for most people.

A good example of this is Tiimo's use of pre-made routines and activities. Instead of typing every activity you plan to do each day, the app has a library of common routines, each with a checklist of activities with allocated start and end times. You can add these to your schedule and tweak them as needed, which is a great way to save time and add a bit more detail to your daily routine.

However, they don't feel quite ready. Routine checklists automatically check themselves off as time passes, regardless of whether you've completed each task. It feels like the app simply assumes you've finished. What's more, when you uncheck an item whose time has passed – for example, if you forgot it and want to mark it as incomplete so you can do it later – Tiimo automatically re-ticks it, regardless of your wishes.



You can add icons and colours to your timeline, making it easier to see what's coming up next at a glance.



Checklists are buggy in other ways, particularly when it comes to the interface. Annoyingly, when you add a checklist item, the on-screen keyboard heavily overlaps the text entry box, which gets mostly cut off. This means that seeing what you're typing is almost impossible.

To be clear, Tiimo does a lot well. So many day planners and to-do list apps are drowning in text, making it hard to quickly see what you need to do. Tiimo, on the other hand, is bursting with colour, emojis, and bold, clear text. It makes absorbing the information on the screen a breeze.

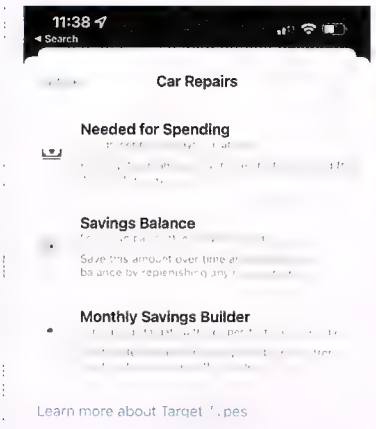
We just wish it didn't feel so half-finished. With a few quality-of-life tweaks it could become a really excellent app, but right now it's stuck in low gear.

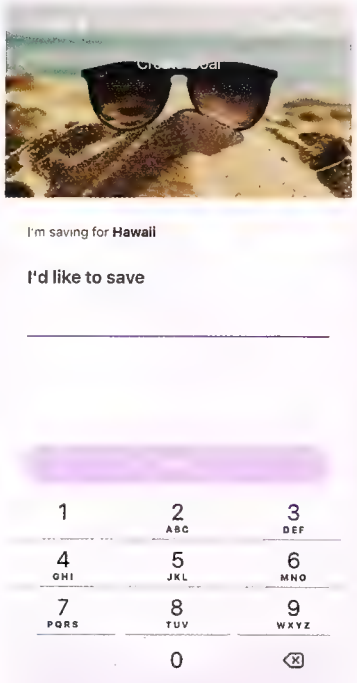
A good planning app with clear visuals, but be ready for some irritations.

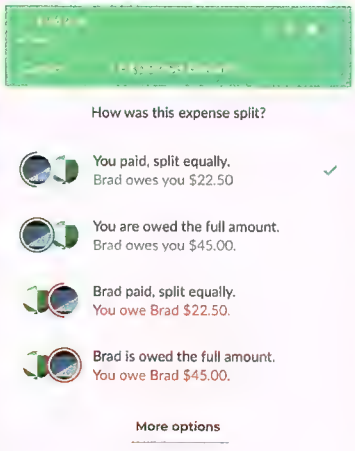
Alex Blake

Let's get financial!

Tim Bothwell shows you how to take control of your spending with these money apps & services.






How was this expense split?
You paid, split equally.
Brad owes you $22.50
You are owed the full amount.
Brad owes you $45.00.
Brad paid, split equally.
You owe Brad $22.50.
Brad is owed the full amount.
You owe Brad $45.00.
More options

Right: YNAB is one of the most comprehensive budgeting apps around. **Middle:** Automatically import and monitor spending with Frollo. **Far right:** Keep tabs on what's owed from friends with Splitwise.

Unless you've been living under a rock, you'll know that inflation has taken much of the world by storm this year. Alongside rising interest rates, increased costs have started to hit all areas of our day-to-day lives, whether it's filling up the car, doing the weekly grocery shop, or just at home thanks to growing energy prices. With that in mind, there's no better time than now to take stock of your current spending habits to identify areas where you could be saving some cold hard cash. In this guide, we'll look at a variety of apps and services designed to help make a noticeable impact where it matters. This includes setting up a budget to monitor spending, keeping track of shared expenses with friends, plus sites that help ensure you're getting the best bang for your buck when it comes to shopping on the web.

"Setting up a budget to monitor spending, keeping track of shared expenses with friends, plus sites that help ensure you're getting the best bang for your buck when it comes to shopping on the web."

BUDGET BASICS

YNAB

US$14.99 /month | www.youneedabudget.com

Let's start first by getting up close and personal with your spending. Sure, it might sound scary at first, but logging your expenses consistently over a number of weeks should give you a much more informed understanding of where your money is going (or disappearing to). You Need a Budget (abbreviated to YNAB) is one of the most comprehensive budgeting apps around. Sold in the form of a monthly subscription (US$14.99 per month with a 34 day free trial), YNAB takes a unique approach to budgeting, asking you to assign 'jobs' for every dollar you have in savings. For example, from a weekly income of $800 you might allocate $200 towards groceries, $250 on rent, $100 for dining out, and $250 on an upcoming holiday. With this mindset you'll budget for things in small increments overtime, making big expenses less overwhelming when it comes time to cough up the cash. As an avid YNAB user myself, it's worth pointing out that the platform can be quite overwhelming at first, so be sure to check out the detailed how-to guides on the YNAB website, or watch one of the many tutorial videos on YouTube.

Frollo

Free | frollo.com.au/app-pb

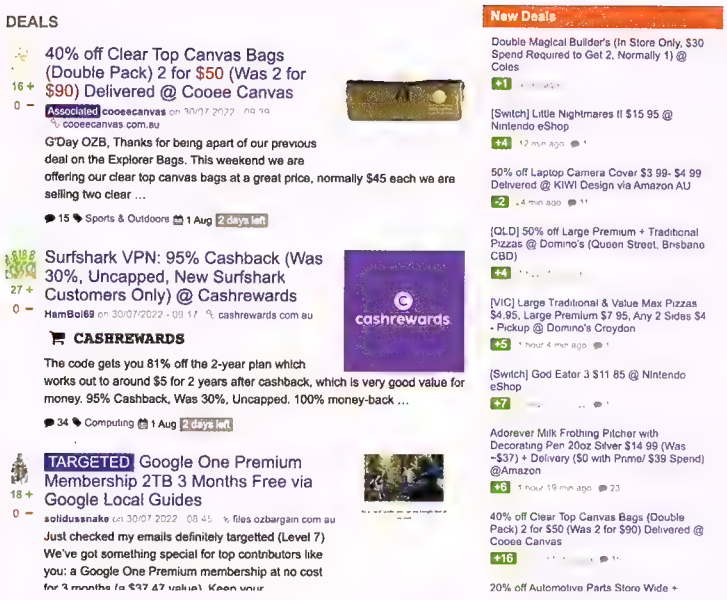
If the thought of manually logging your expenses sounds too time intensive, then you might like to try Frollo. Available on Apple & Android devices (but not desktop), this free Aussie-made budgeting app can sync with select banks and bank accounts to automatically log and track spending. Frollo also sorts & categorises expenses to give you a topline view of your spending habits. As you transact over time, the app will offer personalised insights, for example if spending on a particular category increases significantly, or when a new bill is coming up.

SETTLING THE BILL

Splitwise

Free | www.splitwise.com

There's nothing worse than ending a nice meal out with friends only to


DEALS
40% off Clear Top Canvas Bags (Double Pack) 2 for $50 (Was 2 for $90) Delivered @ Cooee Canvas
Associated cooeecanvas
cooeecanvas.com.au
G'Day OZB, Thanks for being apart of our previous deal on the Explorer Bags. This weekend we are offering our clear top canvas bags at a great price, normally $45 each we are selling two clear ...
15 Sports & Outdoors 1 Aug 2 days left
Surfshark VPN: 95% Cashback (Was 30%, Uncapped, New Surfshark Customers Only) @ Cashrewards
HamBoi69 cashrewards.com.au
CASHREWARDS
cashrewards
The code gets you 81% off the 2-year plan which works out to around $5 for 2 years after cashback, which is very good value for money. 95% Cashback, Was 30%, Uncapped. 100% money-back ...
34 Computing 1 Aug 2 days left
TARGETED Google One Premium Membership 2TB 3 Months Free via Google Local Guides
solidussnake files.ozbargain.com.au
Just checked my emails definitely targetted (Level 7) We've got something special for top contnbutors like you: a Google One Premium membership at no cost
New Deals
Double Magical Builder's (In Store Only, $30 Spend Required to Get 2, Normally 1) @ Coles
[Switch] Little Nightmares II $15 95 @ Nintendo eShop
50% off Laptop Camera Cover $3 99- $4 99 Delivered @ KIWI Design via Amazon AU
[QLD] 50% off Large Premium + Traditional Pizzas @ Domino's (Queen Street, Brisbane CBD)
[VIC] Large Traditional & Value Max Pizzas $4.95, Large Premium $7 95, Any 2 Sides $4 - Pickup @ Domino's Croydon
[Switch] God Eater 3 $11 85 @ Nintendo eShop
Adorever Milk Frothing Pitcher with Decorating Pen 20oz Silver $14 99 (Was ~$37) + Delivery ($0 with Prime/ $39 Spend) @Amazon
40% off Clear Top Canvas Bags (Double Pack) 2 for $50 (Was 2 for $90) Delivered @ Cooee Canvas
20% off Automotive Parts Store Wide +

find that the restaurant doesn't split bills. Sure, someone can pay the amount in full, but with that comes the hassle of following up and reminding people to pay you back. Or perhaps you're living in a sharehouse where bills and expenses are spread amongst the household. In both situations, Splitwise would come in extremely handy. Designed to alleviate the stresses of the occasional "I-O-U", this app allows you to keep a running tally of expenses paid amongst friends so you can see in real-time how much you're owed (or owing to others). Once everyone signs up for an account, simply log a transaction and specify how it should be split amongst the group. You can even upload a photo of the receipt so there's no umming and ahhing around who owes what. Probably one of the best features of Splitwise is the ability to send reminder emails to those with outstanding debts to you.

Beem It.

Free | beemit.com.au

The pain of shared expenses doesn't end there. Next comes the challenge of getting hold of a person's bank details. While there's been a slew of new payment methods designed to ease the process of sending & receiving money between banks, nothing comes quite as easy as Beem It (soon to be rebranded to just Beem). In just a few seconds you can send or request funds from friends, with the money hitting your account instantly. After signing up, simply pick whether you want to pay, transfer, request, or split an expense and follow the prompts. The recipient will then receive a notification with your request. More recently the app has also introduced the ability to purchase and send gift cards to other users – great if you're in need of a last-minute birthday gift.

BARGAIN HUNTING

ShopBack

www.shopback.com.au

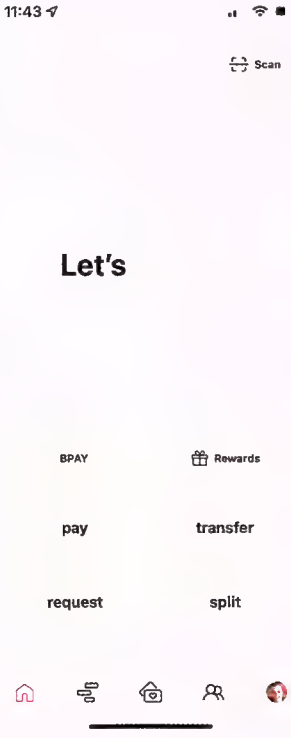
Looking to spend some of the spare cash you've managed to save? Before hitting the checkout, it's worth exploring whether you can get any additional savings using a cashback service. Becoming popular in recent years, cashback services offer additional discounts in the form of money-back on purchases made via select online retailers. ShopBack is one such service that offers discounts for retailers such as The Iconic, Myer and Amazon. Sure, the cashback offer may be small (usually 2-5 percent off the total transaction) but it's still a saving at the end of the day. Be sure to keep an eye out for flash sales where the percentage discount on a retailer increases for a short period of time. It's also a great idea to install the ShopBack browser extension so you're always alerted if there's a cashback offer available.

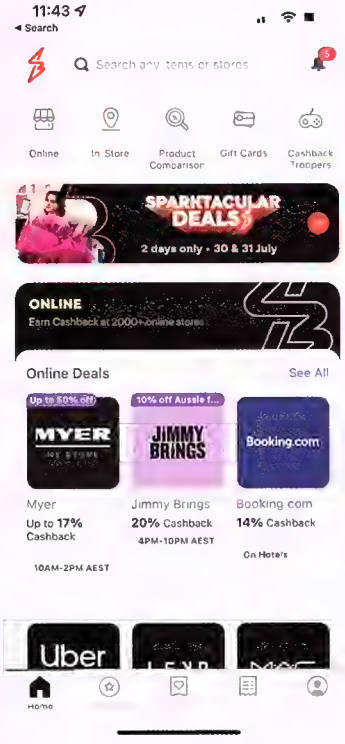
OzBargain

www.ozbargain.com.au

A legacy of the internet, OzBargain is a website dedicated to finding the best deals – if there's a sale going on, then you'll likely find out about it here. Think of it like Wikipedia, with offers published to the site by its users. Simply browse through the list of top-trending sales or discounts as voted by others, or pick from a series of categories such as internet, computing, or travel. The site also has a section dedicated to competitions, along with a forum where you can reach out to the OzBargain community to discuss a range of purchase-related topics. ■

Left: OzBargain is great for finding the best deals.





Far Left: Beem It makes it easy to send and receive money instantly.
Left: Get cashback rewards when shopping online with ShopBack.

25 APPS FOR GEEKS

Treat your inner nerd with our selection of 25 brilliant apps that might just change your life.

The app stores are full of apps that look pretty and do little. This list is the exact opposite. The apps here might not be plastered on the walls of the Design Museum, but they are either unbelievably useful or tug at our geeky heartstrings in some way.

AUTHY

PRICE Free from authy.com

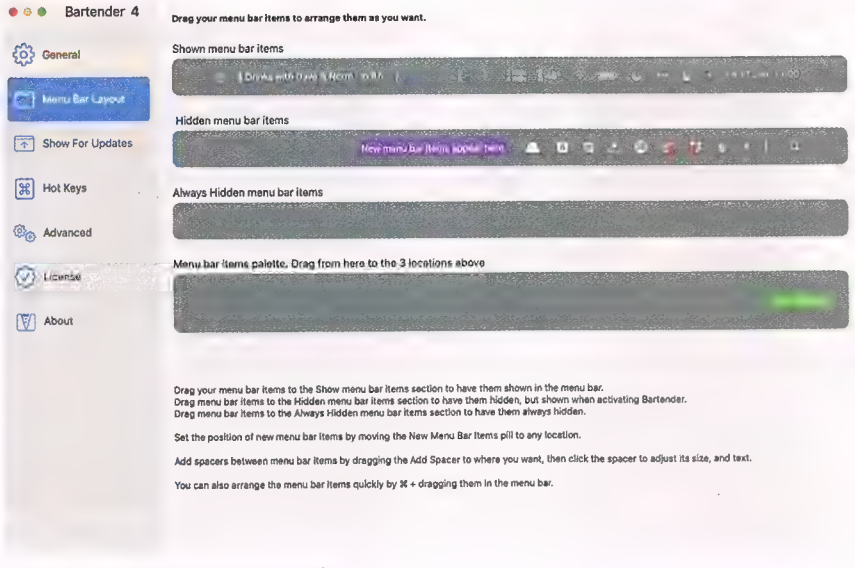
Two-factor authentication is a must-have on any password-protected account, and SMS-based 2FA is not to be relied on. Authy provides a brilliant free alternative, generating time-limited 2FA codes that are compatible with a huge range of online services (including password managers such as Bitwarden). Authy provides several measures to prevent it becoming a single point of failure or from locking you out of accounts should you, for example, lose the phone that provides the 2FA codes. It's cross platform and can be installed on multiple devices, so the absence of one device isn't critical. This is also very useful if you need to change the mobile phone number your account is tied to. In fact, everything with Authy is pretty simple – it does its job effectively, without fuss and without charge.

BARTENDER 4

PRICE US$15 from macbartender.com

The Mac menu bar can quickly become overcrowded, especially if you've installed the other Mac apps we've recommended here. Bartender 4 helps to keep things tidy, letting you keep the vital icons on display and hiding those that you don't need until you mouse-over the menu bar. Bartender is hugely customisable, making it easy to get everything looking just so, right down to the amount of space left between menu bar items. It's not cheap, but it's an OCD balm.

Get yourself organised with the Cron calendar app.


Bartender 4
General
Menu Bar Layout
Show For Updates
Hot Keys
Advanced
License
About
Drag your menu bar items to arrange them as you want.
Shown menu bar items
Hidden menu bar items
Always Hidden menu bar items
Menu bar items palette. Drag from here to the 3 locations above
Drag your menu bar items to the Show menu bar items section to have them shown in the menu bar.
Drag menu bar items to the Hidden menu bar items section to have them hidden, but shown when activating Bartender.
Drag menu bar items to the Always Hidden menu bar items section to have them always hidden.
Set the position of new menu bar items by moving the New Menu Bar Items pill to any location.
Add spacers between menu bar items by dragging the Add Spacer to where you want, then click the spacer to adjust its size, and text.
You can also arrange the menu bar items quickly by ⌘ + dragging them in the menu bar.

Tidy up your Mac menu bar with Bartender.

BITWARDEN

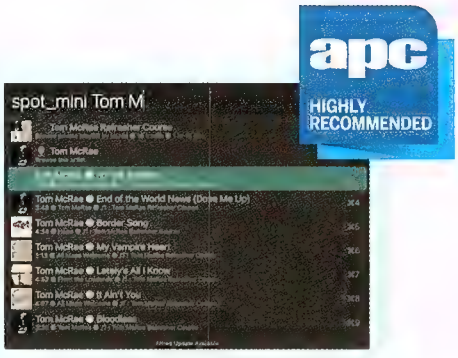
PRICE Free (premium available) from bitwarden.com

There are many reasons why Bitwarden has become a favourite amongst the APC crew. It's not the shiniest or most user-friendly of password managers. There are places where it's a little rough around the edges. But it has more power and features than any of the paid-for alternatives. It can generate random usernames as well as passwords; it can provide two-factor authentication codes (see Authy for an alternative); and its open-source codebase is subject to regular third-party audits, alongside a public bug bounty programme. It's on every conceivable platform and even if you want the non-essential premium features, they are available for a modest US$10 per annum.

CRON

PRICE Free (in early access) from cron.com

There are so many calendar apps out there it's, well, hard to know what day it is. Cron is definitely at the power-user end of the scale. First, it's very keyboard-shortcut driven. Once you master the shortcuts, moving around your calendar is a cinch. It also boasts brilliant features for those working in teams. Need to schedule a meeting with a colleague? You can put a "hold" on several potential meeting slots in your calendar and let them choose.



ALFRED

PRICE Free from alfred.app.com

Alfred is so powerful it's hard to know how to start describing it. At first, it appears to be little more than a Spotlight search alternative – and if you don't pay for the Powerpack, that's precisely what it is. The Powerpack unlocks a raft of tremendously useful features, including a full clipboard history (re-paste that item you copied hours ago), text snippets (enter an entire paragraph of pre-defined text by typing a few letters, such as your address) and workflows. There is a library of workflows to browse (**alfredapp.com/workflows**) or you can create your own. They let you do anything from controlling Spotify without lifting your hands from the keyboard or switching to the app, to searching and launching GitHub repositories. Alfred is one of those apps you'll keep finding new ways to exploit.

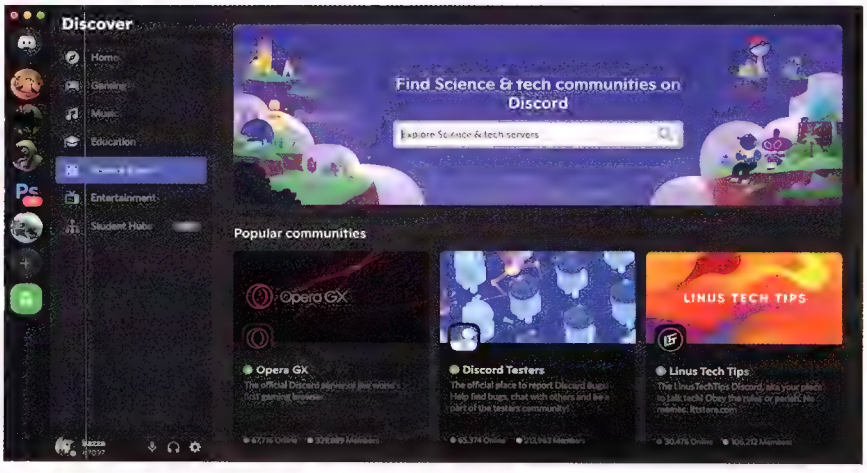
Alternatively, if you're arranging meetings with clients in a different timezone, you can press Z, select their location and have the two timezones shown side-by-side on the calendar so you can arrange a convenient time. Cron has just been bought by Notion, but the app's future is assured, according to the buyout announcement. Of course, that may charge in future.

DISCORD

PRICE Free from discord.com

Discord made its name as the voice/text chat app for gamers, but it's so much more than that. Search the public servers, for example, and you'll find busy communities discussing PC hardware, coding, Linux distros, ethical hacking and tons of other topics to feed your inner geek. It's not only tech-focused, either. When you want to kick back there are communities for learning foreign languages, lo-fi music and Netflix. Discord's audio chat is exemplary, in no small part thanks to the Krisp background noise suppression that's built into the service. We'd honestly have no

hesitation using Discord for business meetings. But it does still excel at the day job – providing voice/video chat while you game, with a discreet Discord panel appearing while you and your crew talk tactics in *Counter-Strike* or some such.



Discord is as useful in business meetings as it is in gaming sessions.

ESPANSO

PRICE Free from espanso.org

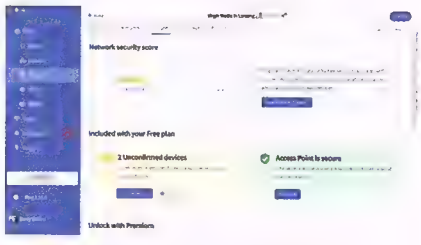
If you constantly find yourself writing the same passages time and again, a text expander such as Espanso could be a true timesaver. Espanso sits in the background, waiting for you to type a keyword in any open app. So, for example, you might type ":address" to have Espanso automatically replace that keyword with your delivery address. You can obviously create your own keywords/substitutes, but Espanso also offers pre-prepared packages. Examples include a package of git commands, another that ensures your correctly camel case brands such as iPhone and WordPress, or a package of HTML5 tags (for example, type :css to get **<link rel="stylesheet" type="text/css" href="">**). You can also create your own company-specific packages to share with colleagues.

FING

iOS

PRICE Free (premium available) from fing.com

There are dozens of Wi-Fi network analysers out there, but Fing combines seriously useful power with a friendly interface. The free version will scan your Wi-Fi network, identify all the devices lurking on it and let you mark them as your own, making it easier to spot when a rogue device enters your network. Each device's brand, model IP and MAC addresses are revealed, and each device on the network can be pinged from within Fing, potentially helping to resolve connectivity issues. Fing offers a premium service that will check your router for vulnerabilities and alert you to any hidden cameras on the network. There's also a Fingbox device that can monitor the connection, block intruders and (slightly creepily) let you know who is at home, based on their devices handshaking with the home network.



Keep a close eye on your network with Fing.

GOLLY

PRICE Free from the App Store

Golly is a simulator for Conway's *Game of Life*, not so much a game as something to gawp at. Trying to explain Life in such a short space is atom-splittingly hard, but you basically draw a patten on a grid and then watch it evolve according to the rules of the game. For example, any "live" cell with fewer than two neighbours dies, as if by overpopulation. This simple app lets you draw a pattern and set the simulator running, seeing how your particular design evolves. Some patterns run for infinity, others end up stuck in loops within seconds. The challenge is to find the interesting ones. It's oddly mesmerising.

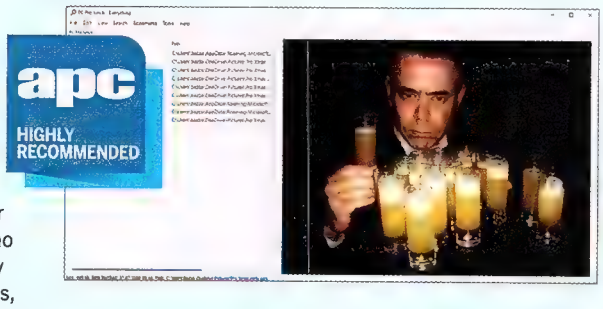
ISTAT MENUS

PRICE $14.99 from bjango.com/mac/istatmenus

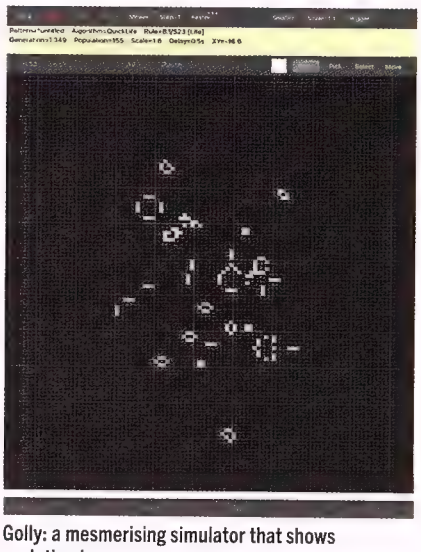
If you're the kind of person who wants to know everything there is to know about what's going on under the hood of your Mac, iStat Menus will deliver. It delivers ridiculously detailed metrics on the temperatures of every component inside your Mac, with each processor core, each memory module, even each palmrest individually measured. CPU and memory loads are also carefully monitored, with an at-a-glance view of which apps are putting the most

EVERYTHING

PRICE Free from voidtools.com



The search facility in Windows has been fist-gnawingly awful for decades, and there's no sign of it improving any time soon. Everything is, well, everything that Windows search should be: lightweight, fast and, above all, comprehensive. By default it will search for pretty much anything stored on your PC – files, folders, executables – but you can easily filter the search if you're hunting for something in particular. When you first install, head to Help | Search Syntax for a very useful list of ways to refine searches. One warning: be careful if you're using the Dropbox facility to only store certain files on your PC. When we searched for something in a Dropbox music collection that wasn't locally synced, it triggered a download of the entire folder.



Golly: a mesmerising simulator that shows evolution in progress.

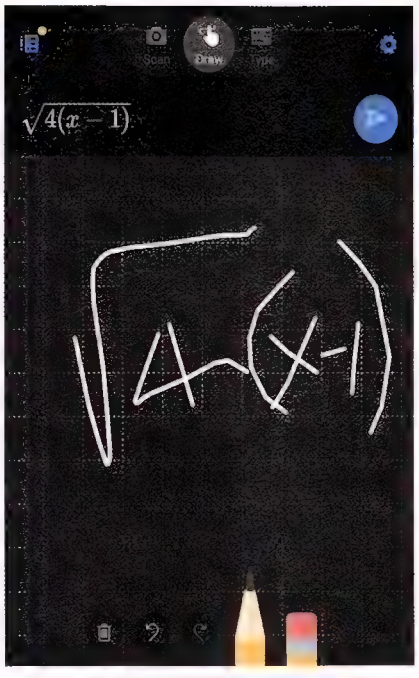
demands on both. Little graphs appear in the menu bar, so you can instantly tell if something is thrashing your Mac and investigate. Even better, all measurement data can be viewed in graphs for the past hour, day, week or month, letting you investigate short- and long-term trends.

MICROSOFT MATH SOLVER

PRICE Free from math.microsoft.com
Microsoft's Math Solver app is a godsend for any parent pressed into helping with maths homework who has long since forgotten how to solve quadratic equations and the like. The app either lets you scan, draw or type in maths problems, which it then solves. The killer feature is that it doesn't only provide the answer, but explains the steps it took to reach the solution, meaning you can guide your stuck prodigy through how to solve the problems one step at a time, rather than simply cheating. If this had been around when we were at school, a lot more Amiga games would have been played.

NATS AIRSPACE EXPLORER

PRICE Free from the App Store
If you're idly looking out of the window at the plane flying overhead, wondering where it's going, you're either an incompetent air traffic controller or you should install NATS Airspace Explorer. This time-sucking app plots the live journeys of the tens of thousands of aircraft in the sky worldwide at any one time. You can click on a plane to get precise details of the flight, the route it's taken, the aircraft's specs and loads more. It's often more fascinating to click on the smaller aircraft – the gliders that have

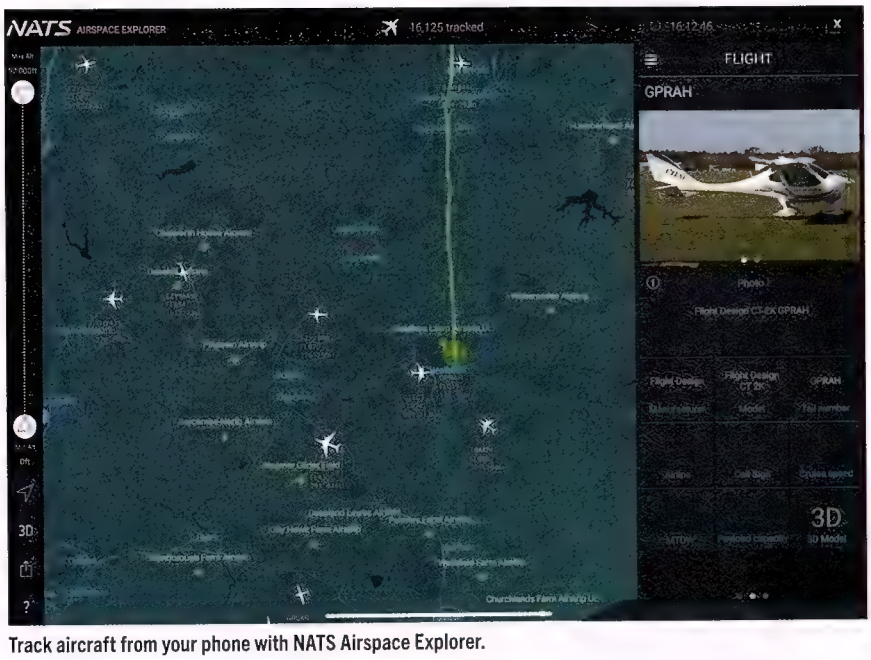


Enter your maths problem, and Math Solver provides the answer.

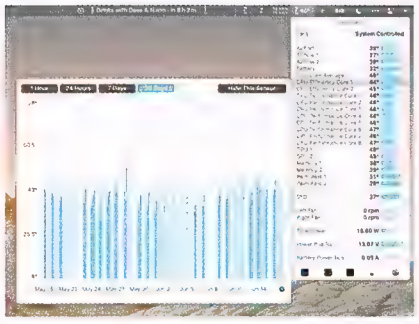
taken off from a local airfield, for example, which normally have a journey map that looks positively nauseating. At the risk of sounding ghoulish, it really comes into its own in times of crisis – tracking planes as we were battered by the storms earlier this year was fascinating, not least to see how many flights were being diverted.

NETWORK INFO II

PRICE Free from the Play Store
Network Info II provides more information about your wireless networks than any human being



Track aircraft from your phone with NATS Airspace Explorer.


The iStat Menus app collates all the metrics on your Mac.

reasonably need know. Perhaps its most useful feature is identifying the network behind virtual networks. When Virgin Mobile was recently transitioning customers from EE to Vodafone, for example, Network Info II gave you the magic MCC+MNC codes that told you who your parent network was (you can check the codes provided against the list at mcc-mnc.com).

RETROSPECS

PRICE Free (premium available)
from the App Store
Ever wondered what GTA V would look like on a Game Boy? Or how a self-portrait would have rendered on an Acorn Archimedes? No, you probably haven't, but the Retrospecs app will let you find out. This app lets you see what today's high-res images would look like on a phalanx of old systems, including the Commodore 64, Teletext, Dragon 32 and Amstrad 464. Most of those systems are only available if you unlock the premium version. It's a fabulous way to waste five minutes and can come in handy if you're creating any kind of retro computing artwork or screenshots.

SHOTTR

PRICE Free from shottr.cc
The Mac's default screenshot app is superb, but Shottr is bettr. Designed with developers in mind, this tiny little utility makes it joyfully easy to take full, part or "scrolling" screenshots, the latter of which capture as much as the page as you need, even if bits are off screen. It's dead simple to delete or pixellate parts of screenshots if they contain something sensitive or irrelevant, and there are strong annotation tools if you need to mark up your grabs. Being dev-friendly, it also includes tools to measure the spacing between elements in the grab, as well as copy the Hex code of colours for use elsewhere.

SYSINTERNALS SUITE

Price Free from the Windows Store
Mark Russinovich's suite of apps is one of the first things many IT pros will install on a new PC. There are the thick end of 30 different

Give images a vintage look with Retrospecs.

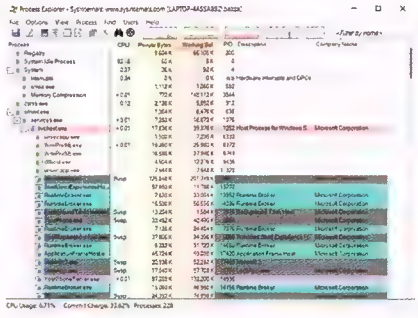
utilities in the suite, but they're mainly one-job apps that won't take up much disk space in total. Process Explorer is very handy for working out what's dragging your PC into the performance doldrums, for example, while Autoruns will help you identify anything that's burrowed its way into the PC's startup routine. It's not all troubleshooting, either. ZoomIt lets you easily zoom into parts of the screen when giving a technical presentation, for instance.

THREEMA

iOS

PRICE $7.99 per app from threema.ch

These are dangerous times for chat apps. With the government seemingly determined to access conversations on high-profile services such as WhatsApp and Facebook, it's arguably safer to stick to the lesser-known services. Threema is highly respected among the security community – indeed, you'll see many infosec journalists using Threema to encourage readers to send them tip-offs. The service can be used anonymously, contacts are only stored on local devices, and encrypted messages are deleted from servers straight after delivery. With all of the features you're used to on WhatsApp, including voice and video chats, it's the lifeboat you might soon be looking for.

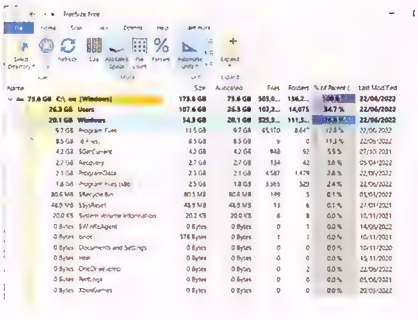


Sysinternals is a professional-level suite of system utilities.

TREESIZE FREE

PRICE Free from jam-software.com

Trying to work out what's eating up all your disk space isn't fantastically easy in Windows. And with laptop makers still routinely banging out systems with SSDs as small as 128GB, every megabyte counts. TreeSize Free does a stand-out job of breaking down what's filling your disks. There's a variety of helpful views to choose from – size, allocated space, file count and per cent – while the "% of parent" column gives you a quick view of what's doing the damage within a particular folder. For example, with two clicks, we can see Microsoft Office is taking up 33 percent of our Program Files folder. TreeSize, on the other hand, is a mere 10.1MB or 0.5 percent of the Program Files (x86) folder, meaning this utility isn't taking up much space itself.



Find out what's taking up space on your disks with TreeSize Free.

VISUAL STUDIO CODE

PRICE Free from code.visualstudio.com

Code editors are a bit like keyboards – everyone has a favourite that they tend to stick with. However, Microsoft's Visual Studio Code has boomed in popularity in recent years, and it's not hard to see why when you start using it. First, it's free, open source and cross-platform, ticking three very important boxes. Syntax highlighting is a given for modern code editors, but combined with the Intellisense "predictive coding", it's a powerful way to enter code more efficiently and avoid silly mistakes. There's a huge library of extensions to make Visual Code Studio more powerful or add support for different languages, and you can debug your code from within the editor itself.

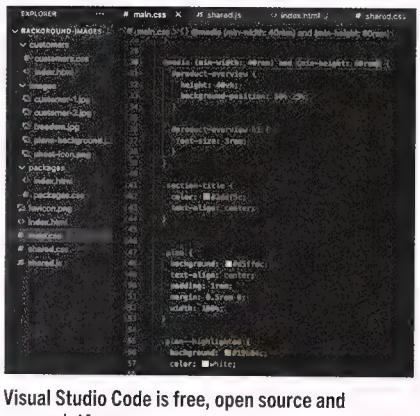
VIVALDI

PRICE Free from vivaldi.com

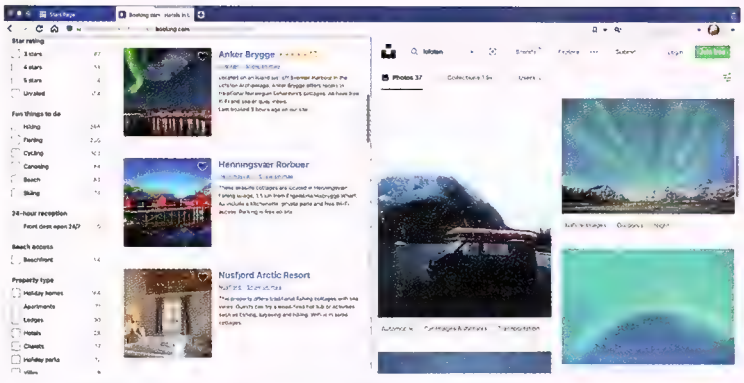
Does your web browser let you type a command to close all tabs to the right of the current one? Does it let you set custom search engines, so you can search Amazon by simply entering "a" ahead of the item you want in the address bar? Does it include an RSS reader and a full-blown email client with offline access? A sophisticated calendar? Tweaks to make it as minimal or UI-rich as you like?

The only way you can answer "yes" to all of those questions is if your web browser is

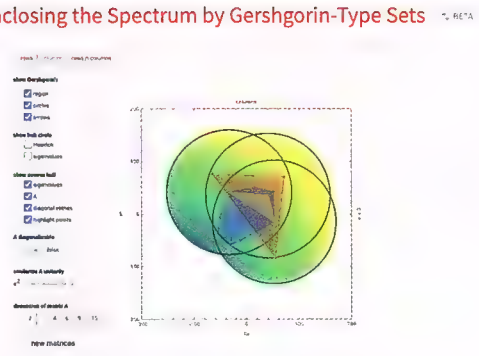
Shottr offers advanced screenshotting capabilities.



Visual Studio Code is free, open source and cross-platform.



Vivaldi is a feature-packed web browser for all four seasons.



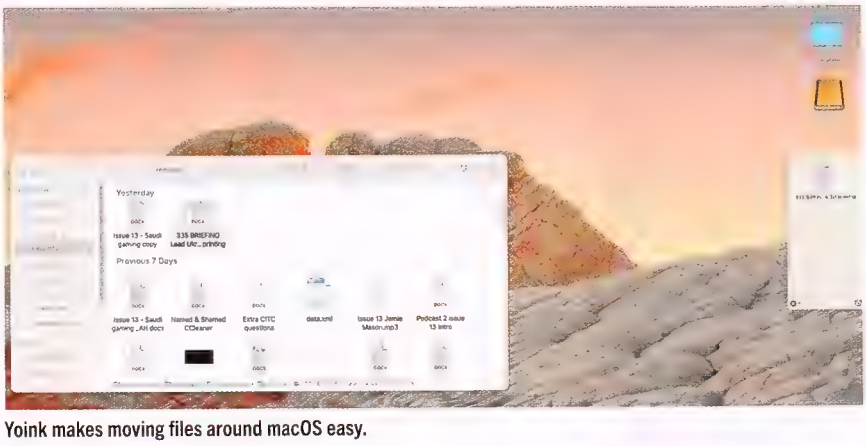
Limitless mathematical power is provided by Wolfram.

Vivaldi, which adds features at a prodigious rate. Almost everything in the browser is hugely customisable, and Vivaldi is strong when it comes to privacy protections too. In fact, there's no iOS version yet, largely because the makers won't bend the knee to Apple's demands to use its browser engine and make compromises.

WIRESHARK

PRICE Free from wireshark.org

Need to know what's actually happening on that piece of Ethernet cable, right down to the packet level? Need to tap into a switch and filter out all the traffic from a particular group of computers? Need to grab this data right now, and then analyse it? Wireshark is the answer. It grabs all the packets on the wire, and saves them to disk. Then you can slice and dice the data, looking for the particular traffic of interest. It's a family of tools, and not easy to get into as a beginner. But it's become the geek's tool of choice simply because it works, and it has all the power you could need for here-and-now analysis of the network.



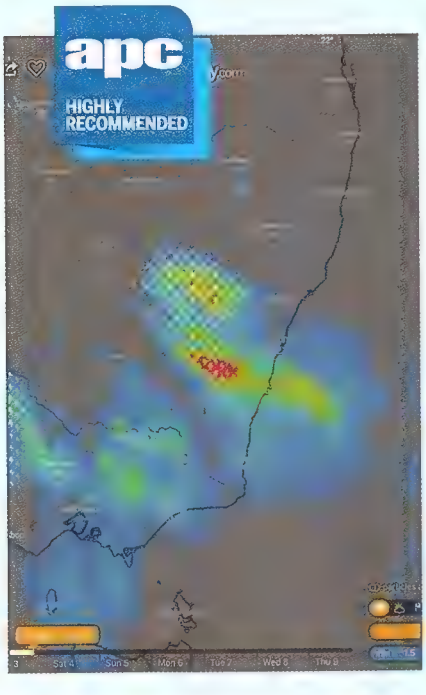
Yoink makes moving files around macOS easy.

WINDY

PRICE Free (premium available) from windy.com

There are so many weather apps in the various stores you begin to wonder if there aren't enough windows in the world. However, Windy is geek meteorological heaven. First, it has dozens of different layers, meaning you can overlay the map with anything from wind gusts (obviously) and dust mass to soil moisture and sea temperatures. Anything you could possibly want to know about the weather is here, and beautifully presented to boot. Better still, it doesn't rely on a single source: you can choose from several different weather models to see if the consensus really is to scrap those BBQ plans for the weekend.

*Windows via browser



WOLFRAM MATHEMATICA

PRICE $414 from wolfram.com

In a sea of great ideas, Wolfram Mathematica stands tall. It's a scary tool to learn but the power within seems limitless, unbounded and exploring more capability than you'll ever use. Code from the first version works today, while the object-based data handling is without peer. And it runs on everything from a Pi to a cluster of high-end workstations. The clarity and focus is extraordinary. If you want to handle data, knowledge and "stuff", then look no further.

YOINK

PRICE $13.99 from eternalstorms.at/yoink/mac

Yoink is a workflow changer, a brilliant little one-function app that makes shuffling files around in macOS so much easier. Start dragging a file in macOS and a little Yoink "shelf" opens on the desktop, providing a temporary repository for files you're moving to a new location. It means you don't need both the source and destination folder open before you start moving files, and you can leave multiple files from various folders in Yoink until you're ready to move them all somewhere new. The file isn't actually moved until you drag it into a new location, so if you change your mind, no harm done. There's a free trial if you want to give it a bash before buying. ■

FEATURE

Tech that changed Australia (and the world) part 5

Just the fourth stored-program computer in the world, it ran calculations for the Snowy Mountains Hydro Electric Scheme and played the world's first computer music. Darren Yates looks back at CSIRAC, Australia's first computer.

Trevor Pearcey looks over CSIRAC, Australia's first computer. (Image: CSIRO Archives)

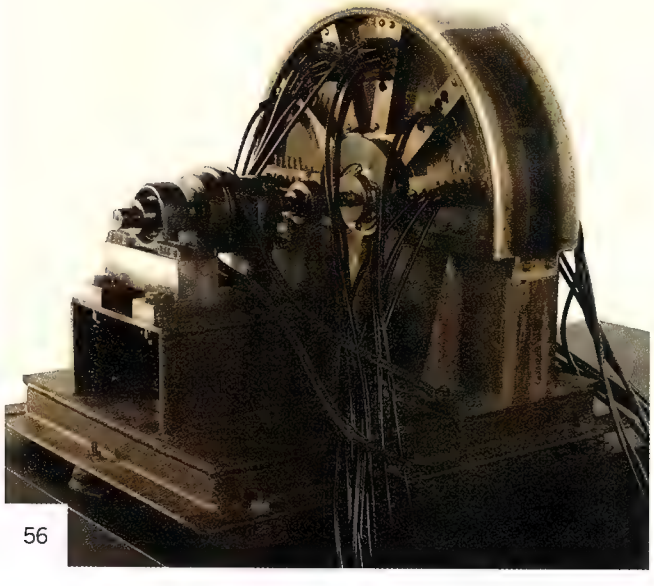
It's fair to say that by August 1945, the previous six years of war had left the world physically and economically exhausted. Yet there remained hope amongst scientists that with war now over, many pre-war research efforts halted by war, along with new discoveries made during it, could now be researched in earnest and take humanity forward. And even if the money wasn't always there, Australia's scientific community was ready for the opportunity – and the challenges.

> "Having seen first-hand the work at MIT and Harvard, Pearcey is likely to have had a hand in radio propagation being replaced by electronic computing as the third research area."

A new start

One of those scientists was a young Trevor Pearcey. Born in England in 1919, Pearcey graduated with honours from London's Imperial College in Mathematics and Physics in 1940. But as war came, he cancelled his planned PhD and instead, worked in air defence research during WWII. At war's end and ready for a fresh start, Pearcey emigrated to Australia to work with the Radiophysics Laboratory at the CSIR, the forerunner to today's CSIRO, arriving in late-1945. On his way, he travelled through the U.S. and saw the electromechanical calculating machines being built and installed at MIT and Harvard University. Much like Colossus-inventor Tommy Flowers during WWII (see Part 3), Pearcey knew mechanical machines would be too slow and that electronic valves could operate at much higher speeds (remember, this is 1945 and the transistor was still two years away).

CSIRAC's disk drive could initially hold 2,500 bytes of storage (Image: Rodney Start, Museums Victoria)



A change of plan

Pearcey joined the CSIR originally as a mathematical physicist working on radio wave propagation. However, around the same time, then-CSIR Radiophysics division boss Edward 'Taffy' Bowen proposed the three areas into which the division would take its first post-war research steps – these were radioastronomy, rain physics and radio propagation. But having seen first-hand the work at MIT and Harvard, Pearcey is likely to have had a hand in radio propagation being replaced by electronic computing as the third research area. By 1947, Pearcey, together with engineer Maston Beard, had begun work on Australia's first electronic stored-program computer, with Pearcey working on the logical design and Beard, an exceptional electrical engineer, tasked with building it.

Importantly, this work was essentially independent from research taking shape elsewhere in the world, resulting in a unique serial-data transfer design with its own programming language.

CSIR Mk. I

Pearcey completed the design in 1947, with construction beginning in 1948. This was followed by work on the programming language and finally, in November 1949, the stored-program electronic computer originally known as 'CSIR Mk. I' ran its first program (the same year the Council of Scientific and Industrial Research was renamed the 'Commonwealth Scientific and Industrial Research Organisation' or CSIRO). For the spec-minded, the CSIR Mk. I used over 2,000 electronic valves, reportedly weighed several tons and consumed 30KW of electricity. It had 768 'words' of memory organised as 20-bits each and a clock speed of 1,000Hz.

Still, even at just 500 operations per second, it was revolutionary in

1949-Australia. Amongst its many tasks, CSIR Mk I was used extensively during the early design of the Snowy Mountains Hydro Electric Scheme, including to analyse flood data for determining optimum dam heights. During its latter stay at the University of Melbourne, it would calculate everything from home loan repayment schedules for university employees to generating solar radiation tables for the CSIRO.

The first computer music

Few of us can remember a time when computers couldn't play music, but even in 1950, the CSIR Mk. I used a speaker (called the 'hooter') fed with electrical pulses to indicate a specific programming event had occurred. It was mathematician Geoff Hill who first toyed with the idea of coding these pulses into continuous tones and by the time of the Conference on Automatic Computing Machines held at the University of Sydney in August 1951, the CSIR Mk. I was playing popular tunes of the day. Other first-generation computers around the world were likewise pursuing this party trick, but the CSIR Mk. I is generally regarded as the first computer in the world to do so. Unfortunately, no recordings were made at the time, but you can hear a faithful reproduction of the original music via **tinyurl.com/APC511MUS**.

Regrets

Like all first-generation computers, the CSIR Mk. I was built by-hand, which was not only an impressive feat in itself, but it was also somewhat temperamental, apparently requiring occasional 'percussive maintenance' via a rubber mallet. Yet despite slow but steady progress to upgrade the computer, the CSIRO, much to Pearcey's regret, had come to a decision by March 1954 to discontinue research into computer development. Computing research was a time-consuming and expensive business and global competition had, by this time, begun to accelerate. This, it seems, led the CSIRO to conclude it couldn't maintain the effort and that its limited funds were needed in other areas. Later that year, the CSIRO offered the computer to the University of Melbourne, where it was renamed 'CSIRAC' in 1956 and spent the remainder of its working life.

Nevertheless, despite Pearcey's regret, CSIRAC successfully served a greater purpose – it launched Australia as only the third country behind the U.K. and U.S. into the computing era and accelerated interest amongst the country's research and industrial communities. Its continuing legacy is seen today in Australia being a noted world-leader in quantum computing, thanks to research at the University of NSW by researchers led by 2018 Australian of the Year, Professor Michelle Simmons.

Still with us today

CSIRAC was switched off for the final time in November 1964, but it's worth celebrating that nearly 60 years later, CSIRAC is still with us. In fact, it is the only first-generation computer in the world that remains intact – even though it no longer operates, you can see CSIRAC on display in the Scienceworks museum in Melbourne.

Trevor Pearcey received a doctorate of science from the University of Melbourne in 1971. He passed away in 1998, but is remembered through The Pearcey Foundation and the yearly national and state awards scheme named in his honour recognising achievement in the Australian ICT industry.

Pearcey helped forge the first steps of Australia's path to a digital future. He also foresaw something over the horizon. In an article for the *Australian Journal of Science* in February 1948, Pearcey wrote "it is not inconceivable that an automatic encyclopaedic service operated through the national teleprinter or telephone system, will one day exist." He lived to see this as the World Wide Web.

Next time, we begin exploring Australia's first post-war steps towards the stars and our world-class pioneering research in radioastronomy. ■

Above left: CSIRAC still exists at Melbourne's Scienceworks museum (Image: Museums Victoria

Above: CSIRAC was hand-built using electronic valve technology (Image: Museums Victoria)

CSIRAC ran rows of thermionic valves, including popular 6SN7 dual-triode types (Image: Museums Victoria)

FEATURE

Hack YouTube

YouTube is an endless source of entertainment, but it can also be frustrating, annoying and invasive. Robert Irvine reveals every secret trick to make the video-sharing service work better.

WHAT YOU CAN DO

- Skip ads and sponsored messages in videos
- Stop YouTube playing videos automatically
- Hide recommendations based on your viewing
- Add download buttons to YouTube videos
- Adjust playback speed to watch videos faster
- Bookmark specific moments in videos
- Increase your default video resolution to 4K
- Switch to a tracker-free version of YouTube

More than 30 million people visit YouTube every day to watch clips of TV shows, music videos, the latest 'viral' content and much more, making it the second most popular website in the world (after Google Search). Sadly, we suspect that many visitors have recently reached the same conclusion we have: YouTube is getting worse.

From unskippable ads and sponsored messages before almost every video to irrelevant 'recommendations' and poor streaming quality, the YouTube website and app have become increasingly frustrating and irritating to use. The once innovative service now reserves its best features – such as the ability to download videos and play them in the background – for its $14.99-per-month Premium subscribers - and has started removing options that viewers find useful, such as the dislike count.

With so much great content to watch for free, YouTube is difficult to ditch completely. The good news is that there are plenty of ways you can 'hack' the video-sharing site to improve your viewing experience, either by installing special extensions in your browser or by tweaking hidden settings.

Here we explain how to fix common YouTube annoyances, add clever new features to the site, improve your streaming quality and protect your privacy so Google doesn't watch you while you're watching YouTube.

MAKE YOUTUBE LESS ANNOYING

Block adverts in YouTube videos

YouTube seems to show more adverts than ever these days, sometimes making you sit through two or even three non-skippable ads before you can start watching a video. It may also interrupt your viewing with 'mid-roll' commercial breaks, especially during longer content, and even play an ad after a video has finished. Many standard ad blockers can no longer combat this nuisance, so unless you pay $14.99 per month to subscribe to ad-free YouTube Premium, there seems to be no escape .

Thankfully, there is a solution in the form of 'Adblock for Youtube', a brilliant extension for Chrome and other Chromium browsers (**tinyurl.com/APC511ADB**) and Firefox (**tinyurl.com/APC511ADFF**). Once installed, this add-on automatically blocks all adverts that appear before, during and after YouTube videos, with no need for any configuration – though you can disable ad blocking if you want to support specific content creators.

Occasionally, there's a brief pause before a video starts playing, but otherwise the only indication that an ad has been blocked is a tiny 'cleaned by Adblock for Youtube' message under the bottom-right corner of the player (see screenshot below). The extension works on YouTube videos embedded on other sites, and can also block annoying annotations that obscure your view.

Alternatively, you can switch to using the privacy-focused browser Brave (**https://brave.com**), which includes a built-in ad blocker that does block most YouTube adverts. The powerful content blocker uBlock Origin (**ublockorigin.com**) is also very reliable at filtering in-video ads.

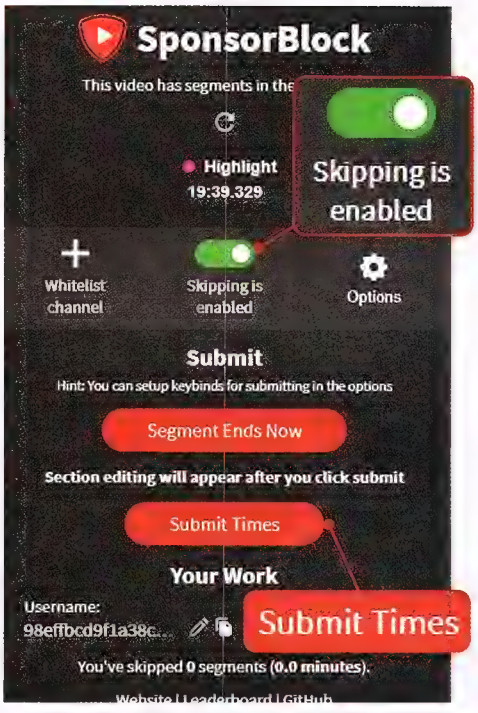
Blocking ads in the YouTube mobile app isn't as easy, and the only real way to avoid them is to switch to an alternative app such as NewPipe (**newpipe.net**).

Skip sponsored messages on videos

Ads aren't the only intrusion when watching YouTube videos - an increasing number of clips are now preceded by lengthy sponsored messages that advertise products and services, or encourage you to subscribe to a channel. These sponsorship messages are able to bypass ad blockers and, although they help to support content creators, they can really test your patience.

You can avoid many of these sponsored messages by installing 'SponsorBlock for YouTube' (**sponsor.ajay.app**), which is available for all the main browsers. This extension lets you automatically skip sponsored intros and outros, subscription reminders and "other annoying parts of YouTube videos" that it identifies from its ever-expanding database (see screenshot above right). It's a crowdsourced tool, which means users can improve its effectiveness by reporting any paid-for promotions they encounter. Click its toolbar button and choose Segment Starts Now when a promotional message begins, then Segment Ends Now when it's over. Click the button to Submit Times, and SponsorBlock will add the segment to its database. You can whitelist YouTube channels to allow them to show sponsored messages or disable skipping temporarily.

SponsorBlock's developer claims the extension now has more than three million users who have saved nearly 585 years between them by skipping sponsored segments around 570,000 times



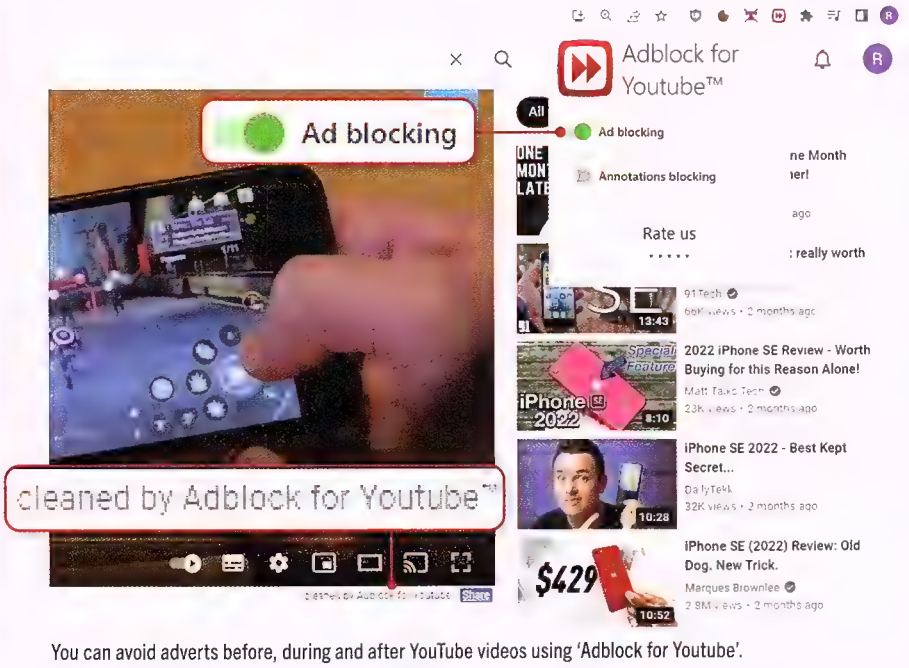
SponsorBlock automatically detects and skips sponsored messages in YouTube videos.

If you don't like the 'info cards' that appear at the end of videos, asking you to subscribe to the creator's channel, you can disable them without an extension. Click your profile picture in the top-right corner of the YouTube site and choose Settings, then 'Playback & performance' and untick the 'Info cards' option.

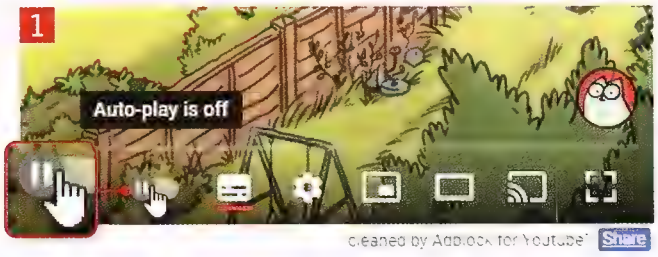
Stop YouTube videos playing automatically

Some people like the way YouTube automatically plays a related video when you finish watching the current one, because it saves you having to search for another clip manually. But for the rest of us, auto-playing videos are more of an annoyance than a convenience, because they drag you down a YouTube 'rabbit hole' and divert your attention from more important tasks. Happily, you can disable auto-playing content and stop YouTube stealing your precious time. When watching a video on the YouTube website, click the Auto-play switch in the controls along the bottom of the player to turn it off - the icon will change from a 'play' to a 'pause' symbol and confirm that 'Auto-play is off'. The same switch is available in the YouTube app for Android and iOS, but appears at the top of the video player.

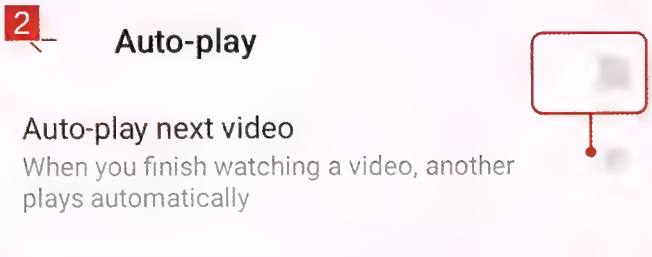
Another way to disable Auto-play is to tap your profile picture in the top-right corner of the app's home screen, choose Settings then Auto-play, and switch off



You can avoid adverts before, during and after YouTube videos using 'Adblock for Youtube'.



You can switch off Auto-play when watching a YouTube video...



...and via Settings in the YouTube app for Android, iOS and smart TVs.

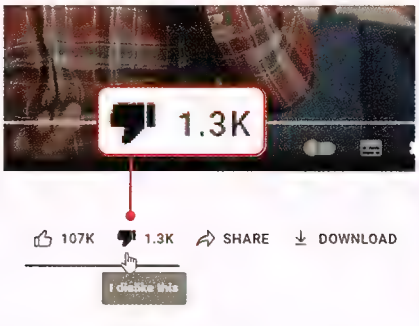
'Auto-play next video' (see screenshot 2). You'll also find this option in the YouTube app for smart TVs, so you can stop videos auto-playing on your big screen.

Restore the dislike count to YouTube videos

Last November, YouTube decided to drop the 'dislike' count from video pages, so you could no longer see how many viewers had clicked or tapped the thumbs-down button. Its official reason was to protect content creators from being unfairly targeted by internet trolls, while still privately being able to see how many people disliked their work. The downside for YouTube users is that you can no longer tell at a glance if a video is likely to be poor quality and not worth watching, because there's no counterbalance to the number of 'likes'.

You can fix this by installing Return YouTube Dislike in Firefox, Chrome, Edge, Brave and other Chromium browsers (**www.returnyoutubedislike.com**). This restores the dislike count to its rightful place below the video player (see screenshot above), so you can see how many times a clip has been downvoted – as well as upvoted – and click to express your own opinion.

The extension has a five-star rating in the add-on stores and more than two million users, so clearly YouTube underestimated the popularity of negativity.



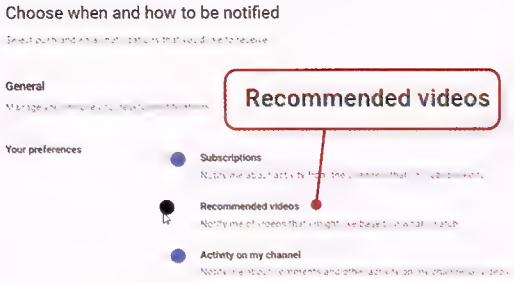
Restore the dislike count to its rightful place below YouTube videos.

Stop YouTube recommending videos

Another way YouTube tries to keep you watching indefinitely is to recommend further videos to watch as soon as you've finished watching the current one. These suggestions are based on your viewing history, but don't always reflect your tastes – especially if you sometimes open videos accidentally. To stop YouTube recommending videos, click or tap your profile picture in the top-right corner of the website or app and choose Settings. Select 'Notifications' and switch off the option 'Recommended videos' (see screenshot above right).

> "When you're watching YouTube at night, the glare of its white background can take its toll on your eyes and distract you from the video you're viewing."

Alternatively, if you don't mind recommendations but find YouTube's suggestions inaccurate or intrusive, you can reset and depersonalise them. Click the History link on the left-hand side of the YouTube website – or go to Settings, 'History & privacy' in the mobile app - and select 'Clear all watch history' and 'Clear all search history'. You can prevent YouTube from recommending videos based on what you watch in future by choosing 'Pause watch history'.

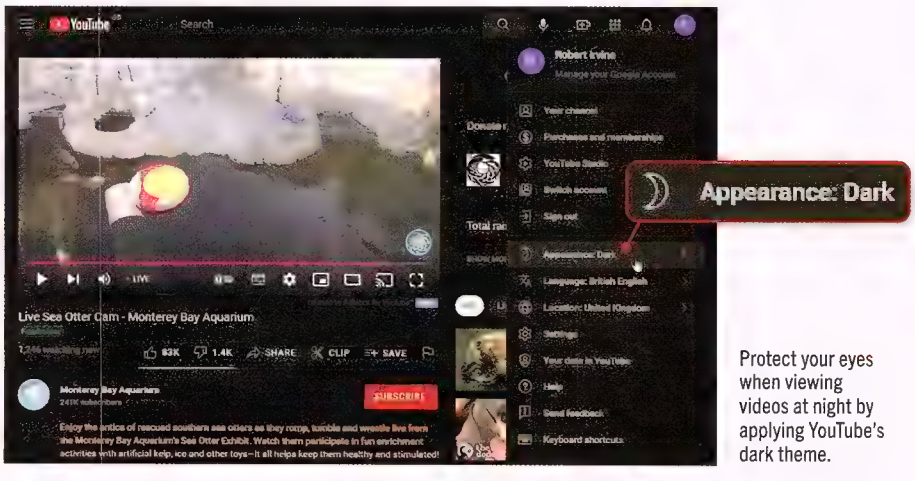


Prevent YouTube from tempting you to watch its recommended videos.

Activate dark mode in YouTube

When you're watching YouTube at night, the glare of its white background can take its toll on your eyes and distract you from the video you're viewing. To make things easier on your vision and create a more cinematic experience, transform all that white into black by activating YouTube's dark mode. On the website, click your profile image in the top-right corner, select Appearance (see screenshot below) and choose 'Dark theme' to turn out the lights. In the YouTube mobile app, press your profile picture, choose Settings and select General. Tap 'Appearance' (Android only) and apply 'Dark theme' there.

For a more nuanced approach to mood lighting, install 'Turn Off the Lights' (**www.turnoffthelights.com**) in your browser. Click the extension's lightbulb toolbar button when viewing a video, and everything else on the page will fade to dark. Then click again to bring the lights back up. You can customise the dark theme in the add-on's Options and use speech recognition to switch it on and off.



Protect your eyes when viewing videos at night by applying YouTube's dark theme.

ADD USEFUL FEATURES TO YOUTUBE

Add download buttons to YouTube videos

Google won't let you download videos from YouTube unless you subscribe to YouTube Premium, which is perhaps not surprising when you consider how much money the site makes from ads. Its terms of service forbid you to download content without permission from YouTube or the respective rights holder, and Google has banned YouTube-downloading extensions from the Chrome Web Store (though there are plenty of tools for grabbing videos from other sites).

However, there's lots of content on YouTube that you are permitted to download, such as public domain videos that aren't copyrighted, clips covered by a Creative Commons licence (**creativecommons.org**) and homemade videos that friends have shared with you.

You can download such videos in Chrome using an extension called Tampermonkey and a script called Local YouTube Downloader. Install Tampermonkey from the Chrome Web Store (**tinyurl.com/APC511MON**) then head to the Local Video Downloader page on the user-script site Greasy Fork: (**tinyurl.com/APC511GRS**). Click the 'Install this script' button, select 'I already have a user script manager, let me install it!' and click Install.

Now when you open a YouTube video page, you should see a 'Download high-resolution mp4 in one click' link below the player (see screenshot below) - ignore the official Download button, which prompts you to subscribe to YouTube Premium. Click this link and, after a short delay, Local Video Downloader will merge the video and audio, and download the result as an MP4 file.

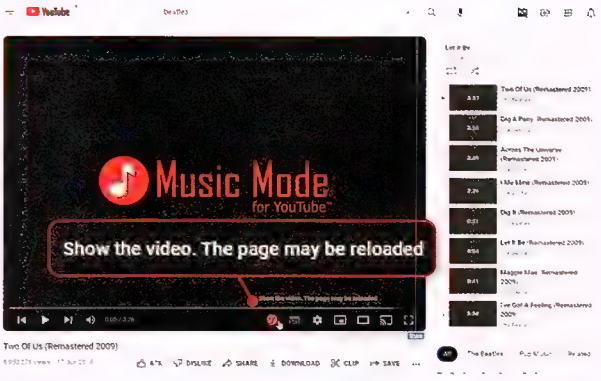
If that sounds like too much hassle, you may prefer to use a browser that supports YouTube-downloading extensions, such as Easy Youtube Video Downloader Express for Edge (**tinyurl.com/APC511VDE**) and Firefox (**tinyurl.com/APC511VDEFF**). This places a Download As button below YouTube videos that lets you grab videos in MP4 format (though to download in Full HD 1080p you must upgrade to the Pro version). You can also save just the audio as an MP3.

An alternative is to download YouTube videos using a third-party program such as 4K Video Downloader (**tinyurl.com/APC5114KVD**). This lets you copy and paste the URLs of YouTube videos, then download them in a choice of resolutions and formats.

Listen to music on YouTube without the videos

Although Google's official music-streaming service is now YouTube Music (**music.youtube.com**), most of us still use the main YouTube website to find and listen to old and new songs on our computers. Indeed, the site has more listeners than Spotify and Apple Music combined. The trouble is that when you only want to listen to music in the background, the accompanying videos can be distracting and many aren't worth viewing – especially when they're just a photo or a cobbled-together collage.

You can hide these unnecessary visuals and turn YouTube into the biggest and best jukebox in the world by installing an extension called 'Music Mode for YouTube' (**tinyurl.com/APC511MM**) in Chrome and other Chromium browsers. This blocks videos so that only the audio plays. It can also hide the thumbnail images for videos and skip ads, saving you bandwidth and preventing interruptions to your listening.

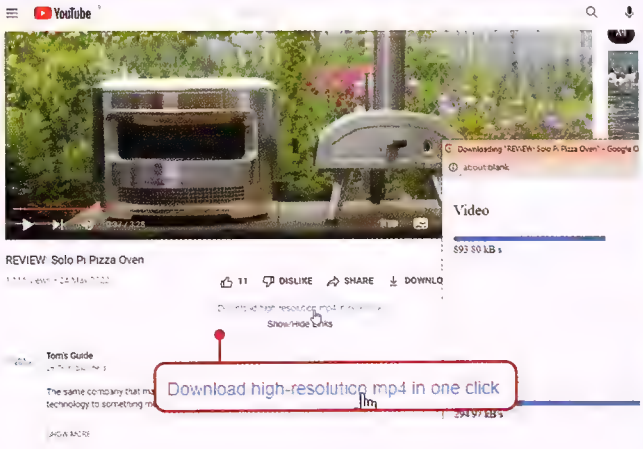


Music Mode for YouTube lets you listen to songs without the accompanying videos.

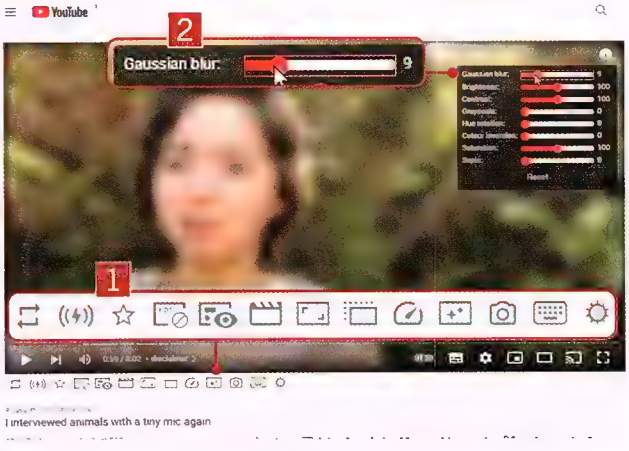
Music Mode also works on YouTube Music and on YouTube videos embedded in other sites. You can switch it on and off easily by clicking the 'Show/Hide the video' icon that the extension adds to the YouTube player's controls (see screenshot above) or by clicking its toolbar button.

Adjust playback speed, apply filters and more

One of the most useful and versatile tools for hacking YouTube is 'Enhancer for YouTube' (**www.mrfdev.com/enhancer-for-youtube** – see screenshot below), which is available for Chrome (and other Chromium browsers), Edge and Firefox. This excellent extension inserts a panel of new options below the YouTube player that let you loop videos, boost the volume, switch to cinema mode, pop out



You can use a Tampermonkey script to add download links to YouTube videos in Chrome.



'Enhancer for YouTube' adds lots of useful and clever features to the video player, including filters.

the content to a floating player window and fix several annoyances we covered in the previous section, such as skipping ads and removing info cards. You can also use keyboard shortcuts to toggle these features on and off.

However, our favourite option in Enhancer lets you control the playback speed of videos by pressing Ctrl and scrolling your mouse wheel – scroll up to whizz through the content much faster or down to view it in slow motion. This is much more convenient than using YouTube's own playback controls (which you access via the Settings cog), and you can set your preferred speed in the add-on's Options.

Other useful features include the ability to capture screenshots of videos with a single click of the Screenshot button, and to adjust the picture quality using video filters such as Brightness, Contrast and 'Gaussian blur'. If you only install one extension for hacking YouTube, it should be this.

Watch YouTube videos with friends and family

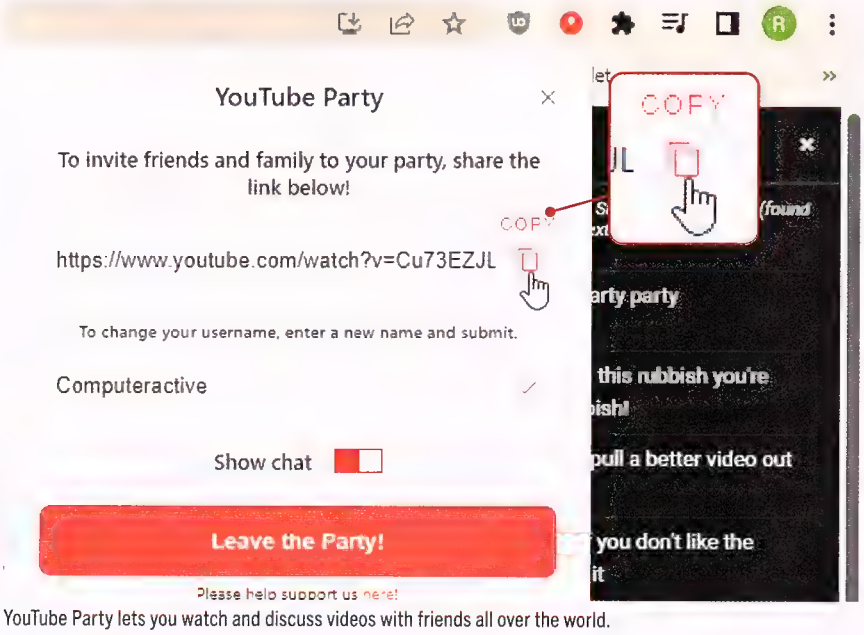
Watching YouTube videos tends to be a private experience, but there are times when you may want to watch along with other people, such as during an online presentation or when playing recordings of family events, full-length films or nostalgic playlists. Install YouTube Party (**tinyurl.com/APC511YTP**) in any Chromium browser and you can sync your viewing with that of friends and relatives anywhere in the world, to enjoy and discuss videos at the same time.

The extension is very easy to use – simply open the video you want to watch with other people, click the YouTube Party toolbar button, enter a username and click 'Start the Party'. Copy and paste the link provided (see screenshot below left) into an email or social-media message, send it to your participants and ask them to install the add-on. When they click the link, they'll automatically join the watch party, and you can all talk about what's happening on-screen in the chat panel that opens on the right-hand side of your browser. To return to viewing the video privately, click the toolbar button again and choose 'Leave the Party'.

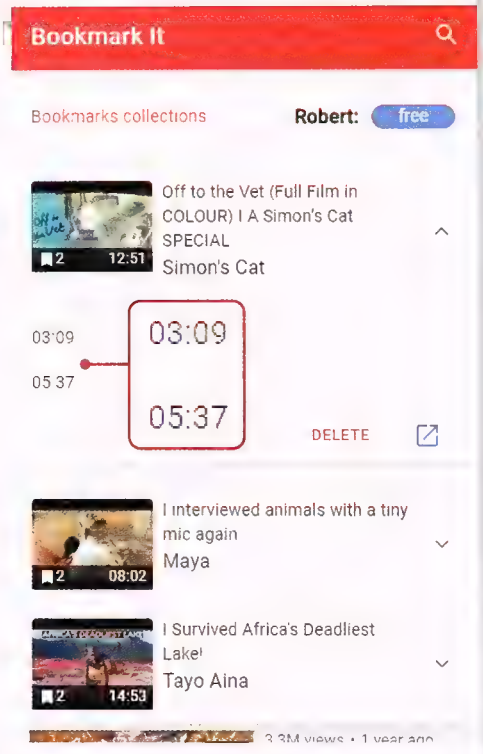
Bookmark specific moments in videos

The simplest way to revisit a specific moment in a YouTube video is to click the three-dot button below the bottom-right corner of the player and choose 'Show transcript'. You can then scroll through the transcript and click a timestamp to jump to that point in the video. However, an even better option is to bookmark the best parts of videos, so you can access them instantly later. That's the idea behind Bookmark It (**bookmark-it.happydevelopers.co**).

Available for Chromium browsers and Firefox, this extension lets you save specific moments in YouTube videos, with the option of adding notes to these bookmarks. To use Bookmark It, click its toolbar button and choose Log In/Register to sign up for a free account (you can use your Google account to save time). Now start playing a YouTube video and, when you get to a good bit, press B on your keyboard to create a bookmark and add a comment. Press 'Enter' to save or Esc to cancel. You can access your bookmark collection by clicking Bookmark It's toolbar button, and click the timestamps (see screenshot above right) to revisit your saved moments in the relevant videos. Click 'Delete' to remove bookmarks once you've finished with them.



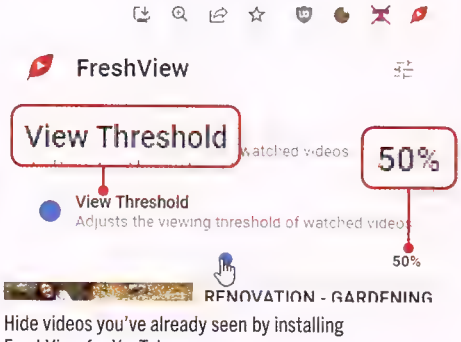
YouTube Party lets you watch and discuss videos with friends all over the world.



Save interesting moments in YouTube videos and revisit them later using Bookmark It.

Hide videos you've already watched

There are some YouTube videos you'll want to play again and again, but for many others, once is enough. You can usually tell which clips you've already watched by looking at the red progress bar along the bottom of their thumbnail images, but wouldn't it be better to hide these videos so you can focus on new content? That's the purpose of 'FreshView for YouTube' (**tinyurl.com/APC511FV**), which automatically removes videos from YouTube's homepage, search results, channels, playlists and recommendations once you've seen them. Usefully, you can specify a 'view threshold' so that FreshView removes a clip only after you've watched more than, say, 50 per cent of it (see screenshot below).



Hide videos you've already seen by installing FreshView for YouTube.

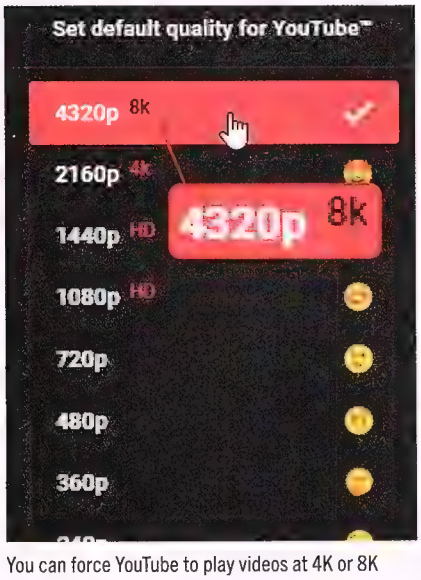
IMPROVE YOUTUBE'S STREAMING QUALITY

Play YouTube videos in 4K and 8K

YouTube automatically adjusts the streaming quality of videos, based on the current speed of your internet connection. If it's really slow, you may only get standard definition (360p or 480p), but otherwise the default quality is 720p high definition. You can change this manually by clicking the cog icon below a video and selecting a resolution option from the Quality menu. However, you may decide that you always want to stream at the highest quality. There are lots of extensions that let you override YouTube's settings to stream in 4K or even 8K, where available, but our favourite is 'Auto HD/4k/8k for YouTube'.

Install this add-on in your Chromium browser (**tinyurl.com/APC5114K8K**) or Firefox (**tinyurl.com/APC5114K8KFF**), then click its toolbar button and set your preferred quality for YouTube videos. The options go up to 4320p, or 8K (see screenshot below), but note that the quality will default to 1080p (HD) on videos where 4K or 8K aren't available. Click 'Auto' to return to using YouTube's automatic setting. The brilliant extension 'Enhancer for YouTube' has a similar option - click its Options cog, tick the 'Automatically select a playback quality' box in the 'Playback quality' section and set your preference, up to 8K.

You can increase the video quality in YouTube's mobile apps by tapping your profile picture and choosing Settings then 'Video quality preferences'. Select 'Higher picture quality' for Wi-Fi and for mobile networks - though bear in mind that this will use more data. To set a specific resolution, tap the Settings cog in the top-right corner of a video and choose Quality, then Advanced.



You can force YouTube to play videos at 4K or 8K resolution where available.

Stop YouTube videos buffering

If YouTube videos often 'buffer' - which means the video freezes during playback because the data stream can't keep up - the problem may be a slow internet connection or a lack of memory or processing power on your PC. Reducing the video quality using one of the methods described in the previous tip can help prevent buffering, but if not, Enhanced-h264ify (**github.com/alextrv/enhanced-h264ify**) may do the trick.

Available for Chromium browsers and Firefox, this extension stops YouTube using VP8 and VP9 codecs to stream videos, and makes it use a format called H.264 instead (see screenshot above right). This format is 'hardware accelerated' by GPUs to deliver smooth video playback using less processor power, which is especially useful on older, lower-spec PCs. It also lets you stop videos playing at 60 frames per second (fps), which can cause problems on less powerful computers.

To check whether a video is likely to cause buffering problems, right-click it and choose 'Stats for nerds'. A panel will open revealing your current connection speed and your 'Buffer Health', which shows how much data YouTube is preloading to prevent playback hitches.

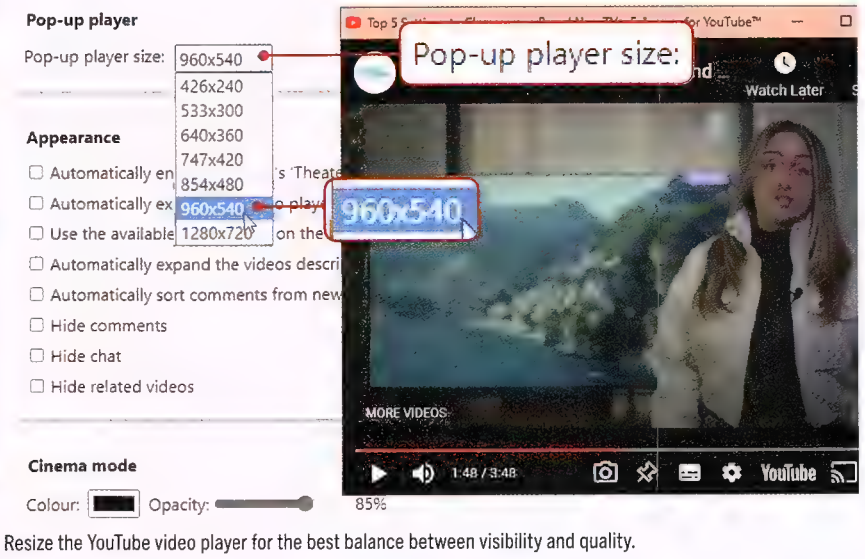
If videos keep buffering on your phone or tablet, try switching to 'Data saver' mode on the 'Video quality preferences' screen. This will reduce the picture quality but make streaming smoother. You can set this mode to activate automatically when your connection is slow by tapping 'Data saving' in Settings and enabling 'Data-saving mode'.

Enhanced-h264ify can stop YouTube videos buffering on older computers.

Resize the YouTube video player

As well as its standard player, YouTube lets you view videos full-screen, in 'cinema mode' (which stretches the player to the width of your browser) and in a mini player in the bottom-right corner of your browser. These are useful, but we prefer the flexibility of 'Enhancer for YouTube'. This extension provides a pop-out video player that you can resize to strike the best balance between visibility and quality, and lets you watch videos while visiting other sites.

Simply click the 'Pop-up player' icon in the extension's control panel to move the video to a floating player window, which you can then move around your screen and resize by dragging its corners or edges. The player has its own taskbar button, so you can open it independently of your browser. To set a default size for the pop-up player, click the extension's Options cog, scroll down to 'Pop-up player' and choose your preferred dimensions in the dropdown menu (see screenshot below).



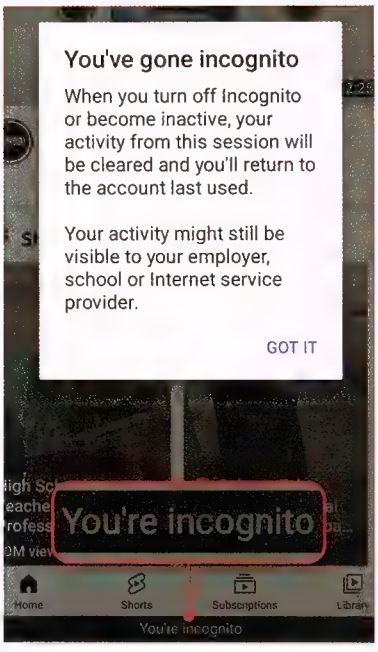
Resize the YouTube video player for the best balance between visibility and quality.

PROTECT YOUR PRIVACY WHEN WATCHING YOUTUBE

Watch videos in Incognito mode

The YouTube apps for Android and iOS feature a handy Incognito mode that lets you search for and watch videos without the details being stored and used to target you with ads and recommendations. To switch to this mode, which behaves as if you're signed out of your Google account, tap your profile picture in the top-right corner of the app and choose 'Turn on Incognito'. You'll see a message confirming that "you've gone incognito" and a black bar along the bottom of the app that says "You're incognito" (see screenshot left). Incognito mode switches off automatically after you've been inactive for 90 minutes, or you can exit it manually by tapping your profile picture again and choosing 'Turn off Incognito'.

To go incognito on the YouTube website, you need to switch to your browser's private mode. However, this will prevent you from viewing age-restricted videos that require you to be signed into your account. You can beat that restriction by installing the extension 'Age Restriction Bypass for YouTube' (**tinyurl.com/APC511AGE**), although it's available only for Edge and Firefox.

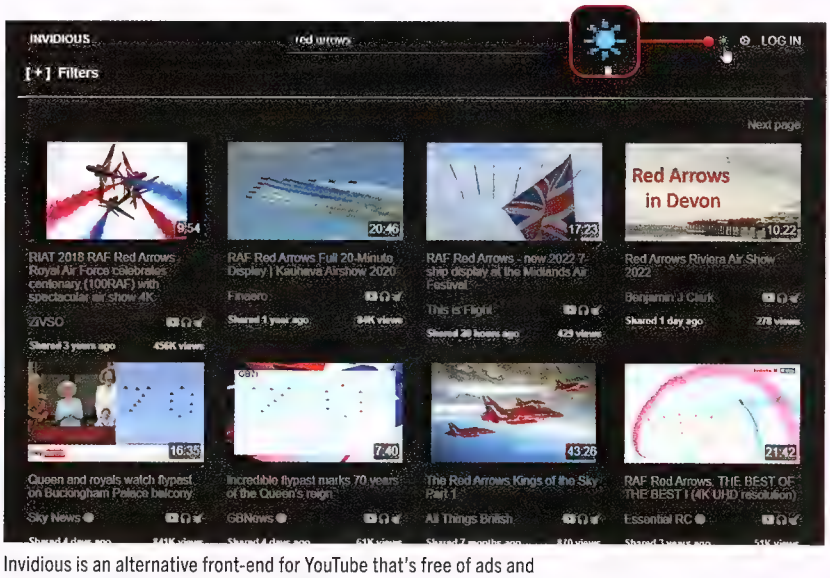

You've gone incognito
When you turn off Incognito or become inactive, your activity from this session will be cleared and you'll return to the account last used.
Your activity might still be visible to your employer, school or Internet service provider.
GOT IT
You're incognito
Home
Shorts
Subscriptions
Library
You're incognito

Switch to incognito mode to stop YouTube storing details of videos you watch

Switch to a private version of YouTube

Watching videos on YouTube means being watched yourself, because Google tracks your viewing habits to target you with adverts. You can protect your privacy by switching to an alternative front-end for YouTube that's free of ads and trackers. The best option is Invidious (**tinyurl.com/APC511INV**), which ceased operation two years ago but lives on through other 'instances' (websites) that have adopted its source code, such as this one: **tinyurl.com/APC511INV2**. Invidious provides a clean, Google-free YouTube experience, complete with a large video player, one-click dark mode (see screenshot below) and the ability to download audio and video.

Alternatively, FreeTube (**github.com/FreeTubeApp/FreeTube**) is an open-source YouTube player for Windows, macOS and Linux that lets you watch, search and download videos on your desktop, without ads or tracking. It also offers Chromium and Firefox extensions that open YouTube videos directly in FreeTube. On an Android device, you can protect your privacy by switching from the YouTube app to NewPipe.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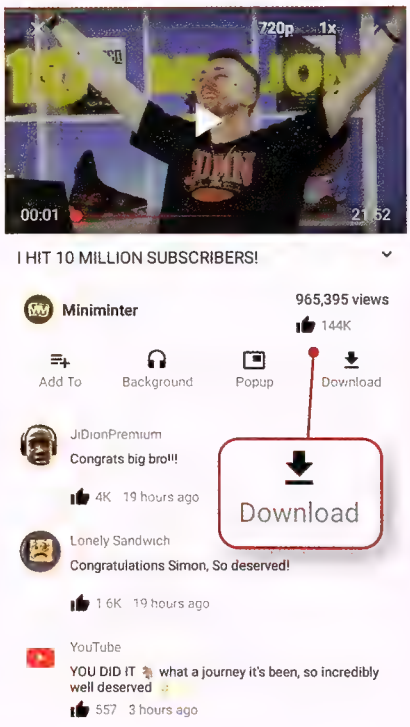
red arrows
LOG IN
[+] Filters
Next page
Red Arrows in Devon
RIAT 2018 RAF Red Arrows Royal Air Force celebrates centenary (100RAF) with spectacular air show 4K
RAF Red Arrows Full 20-Minute Display | Kauhava Airshow 2020
RAF Red Arrows - new 2022 7-ship display at the Midlands Air Festival
Red Arrows Riviera Air Show 2022
Queen and royals watch flypast on Buckingham Palace balcony
Incredible flypast marks 70 years of the Queen's reign
The Red Arrows Kings of the Sky Part 1
RAF Red Arrows. THE BEST OF THE BEST ! (4K UHD resolution)

Invidious is an alternative front-end for YouTube that's free of ads and trackers, and has a one-click dark mode.



DITCH THE YOUTUBE APP FOR NEWPIPE

If you have an Android phone or tablet, you can enhance your YouTube experience, remove ads and protect your privacy by switching to a free app called NewPipe (**newpipe.net**).

This alternative front-end for YouTube lets you browse and watch exactly the same videos, but without Google spying on you. It uses less battery power and data than the official YouTube app, and lets you use Premium-only features for free, including downloading videos at HD quality and playing content in the background while you use other apps.

The main catch is that NewPipe isn't available from the Google Play Store, so installing it is a bit of a hassle, but definitely worth it. First visit **tinyurl.com/APC511FDRO** in your mobile browser and tap the Download F-Droid button. If warned that the "file might be harmful", select 'Download anyway'. Tap to open the F-Droid APK file and choose Install then Open. Press the search icon in the bottom-right corner, search for New Pipe and tap the button to install the app. If you see a warning about installing unknown apps, tap Settings and switch on the option to 'Allow from this source' (F-Droid). Tap 'Install' and NewPipe will be installed on your phone or tablet.

Open the app for an ad-free YouTube experience, with a Download button below videos (see screenshot) that lets you save them to your Android device. ■

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GEFORCE G

GOING BIG ON BANDWIDTH

THE FUTURE OF THE PC PLATFORM

Forget CPUs and GPUs. As Jeremy Laird explains, the PC's future is all about more bandwidth, for everything from storage to memory and even display interfaces.

If the rumours and roadmaps are to be believed, the PC is about to enter a new golden age of innovation. Intel and AMD are prepping epic new processors, while Nvidia and AMD are tooling up to recalibrate expectations when it comes to generational performance increases with their next graphics cards. It's going to be explosive.

Yet there's so much more to the PC than just CPUs and GPUs. The PC platform itself and the peripheral technologies around it are just as important. Imagine storage tech hadn't advanced in the last 20 years. Or memory speeds. Or platform interlinks. Good luck gaming at 4K and 144Hz with that fancy GPU running over an AGP interface, your DDR memory chugging along at 100MHz, an 80GB magnetic HDD that cranks out less than 1MB/s of random access performance, and a video connector that tops out at 1080p and 60Hz.

You get the idea. The next few years are undeniably going to be exciting when it comes to those two headline-grabbing components, the CPU and the GPU, but there's plenty more going on with the PC....

If the PC is ultimately a platform, let's start with the foundation to it all, the motherboard and motherboard chipsets. On the AMD side of the equation, we now have a pretty clear idea of what's coming next. CPU-wise, that's the Zen 4 architecture as found in the new Ryzen 7000 CPUs. Those new CPUs will slot into a new AM5 socket, which should be available to buy by the end of this year. Yes, the AM4 socket introduced six years ago is finally being replaced.

The good news is that not only does AM5 bring a new tranche of features and capabilities but, going on past AMD form, it should stick around for some time. Inevitably, there will be a cost penalty of being an early adopter of AM5 tech, but the expected longevity of the socket should allow for tasty upgrade opportunities down the road. And when we say upgrade opportunities, we're not just talking about the CPU. AM5 and the new chipset that comes with it lay the foundations for numerous platform upgrades.

Starting with the socket itself, AMD is finally making the move from the AM4 PGA or pin-grid array to LGA land-grid array. In simple terms, the pins move from the CPU to the socket, while the CPU itself is then fitted out with an array of contact pads. There are pros and cons to both systems. Arguably, the pins on a PGA CPU are easier to straighten than damaged pins in an LGA socket. On the other hand, a bust motherboard is likely cheaper to replace than a bent high-end CPU.

Whatever, AMD's new AM5 socket, also known as LGA1718 for the number of pins found within, certainly breaks backward compatibility with all previous AMD CPUs. But that is the price of progress and AM5 delivers plenty of that. First up, AM5 and Ryzen 7000 bring support for the latest Gen 5 version of PCI Express. The socket itself has 16 PCIe 5 lanes for the graphics card and getting on for 64GB/s of bandwidth to the CPU just for graphics. There are also two dedicated four-lane PCIe 5 direct-to-CPU interfaces for connecting storage, providing up to 16GB/s of theoretical SSD bandwidth.

Intel has already given its PC platform a major overhaul with the 12th Gen Alder Lake CPU family and 600 series chipset.

By way of comparison, the AM4 platform provided 24 lanes of PCIe Gen 4 direct to the CPU, including the chipset downlink, so AM5 has double the bandwidth across the board. Also hooking directly into the AM5 CPU socket is a PCIe Gen 4 quad-lane interface that provides 8GB/s of bandwidth for the ASMedia USB 4 controller. USB-wise, there are further dedicated direct-to-CPU USB interfaces, one USB 3.2 Gen 2 10Gb/s Type-C with support for DisplayPort 2.0 UHBR10 Alt Mode, a single USB 3.2 Gen 2 10Gb/s Type-A with BIOS flash support, and three USB 2.0 USB-A connections.

Speaking of display interfaces, all-new Ryzen 7000 CPUs will have integrated graphics, much like Intel's desktop CPUs have had for years. So, AM5 and Ryzen 7000 are fitted with the very latest display connections, including support for both the aforementioned maximum spec DisplayPort 2.0 with UHBR10 support and HDMI 2.1 FRL. You can read more about what those display interfaces enable in the boxout on page 71, but suffice to say, if you want really high resolutions, as well as nose-bleed-inducing refresh rates with HDR enabled, you're going to want some DisplayPort 2.0 action.

Oh, and there's the minor matter of DDR5 memory support. Well, not just support but rather compulsory use thereof. Unlike Intel, AMD tends not to offer support for multiple memory types on the same platform, so DDR5-only it is for AM5. Which is more than fine. Admittedly, DDR5 has been pricey thus far, but costs are now coming down and by the time AM5 becomes a mainstream option, DDR5 could actually be cheaper than DDR4 while offering much more performance. For now, it's not clear how high AM5 and Ryzen 7000 will go at launch in terms of DDR5 memory speed support.

It's also worth noting that AMD has increased the socket TDP power rating from 105W with AM4 to fully 170W for AM5, which is a hefty bump and will allow for some very powerful future CPUs. If that's the AM5 socket-related features covered, what about the chipset? Here, AMD is also going outside the box with a novel dual-chip arrangement on its high-end chipsets for the new Ryzen 7000 CPU family.

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AMD's Zen 4 Ryzen 7000 CPU will bring a plethora of platform upgrades for AMD fans.

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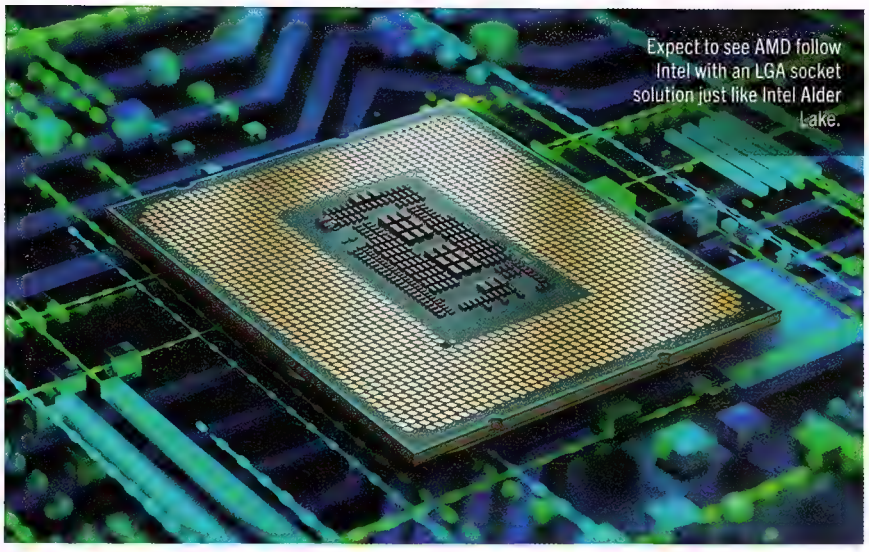

Expect to see AMD follow Intel with an LGA socket solution just like Intel Alder Lake.

daisy-chained together. It's a novel solution and will save significant cost compared to tooling up multiple motherboard chips with different feature sets. Each chip is also smaller and built on a more advanced process than those of AMD's 500 series chipsets. So, they use less power, around 7W per chip, and can be run with passive cooling, which again will make for cheaper and more reliable motherboards.

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For starters, Raptor Lake will stick with Intel's existing V0 or LGA1700 socket, albeit the fine detail in that area is a little

DDR4 VERSUS DDR5

IS FASTER MEMORY WORTH THE WALLET WALLOP?

If money's no object, faster memory is always nice. But money is an object and DDR5 memory has proven particularly pricey. Blame the pandemic or any of a number of freak geopolitical events over the past few years, but it does beg the question of whether DDR5 is worth the wallet pain.

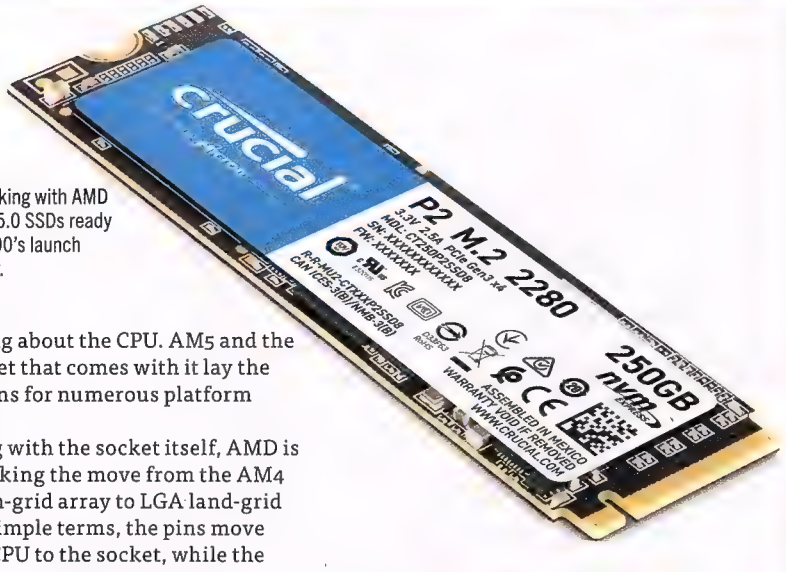
It's a particularly pertinent question with Intel's 12th Gen Alder Lake CPUs. How so? Well, Alder Lake rather handily supports both DDR4 and DDR5, so the new memory standard isn't compulsory, as it will be with AMD's new AM5 socket and Ryzen 7000 CPUs later this year. For now and with Alder Lake, DDR5 therefore really has to deliver. Otherwise, why would you pay more? After all, Intel has a poor track record for maintaining long-term socket compatibility. So, it's unlikely if you invest heavily now in Alder Lake and DDR5 you'll be all set for dropping in a new CPU two or three generations down the line. Indeed, we're expecting Intel to break socket compatibility next year with the 14th Gen Meteor Lake processor family.

Alder Lake officially supports DDR4-3200 and DDR5-4800. That looks like a fairly big gap in terms of headline memory speed from the DDR5 option. What's more, in terms of raw bandwidth, DDR5-4800 delivers around 56GB/s, well over 10GB/s more than the DDR4 option. But in actual real-world applications, the benefits aren't always so obvious. In games, all that extra bandwidth doesn't really translate into better frame rates. In productivity apps such as Photoshop, a five percent boost in performance is about as good as you can expect, while the odd outlier such as Zip compression sees the full force of the bandwidth pay off and a performance boost of about 20 percent.

All of this means DDR5 hasn't been too appealing paired with Intel's Alder Lake CPUs. As for being forced to go with DDR5 when AMD's next-gen platform arrives later this year, the good news is that DDR5 prices are beginning to fall. And as DDR5 moves from early adopter status to mainstream, it will eventually transition to being cheaper than DDR4, thanks to economies of scale. That won't happen in time for the launch of Ryzen 7000, but it shouldn't be too painful to spec up a next-gen AMD rig with a decent amount of DDR5 memory.

Does DDR5 deliver in real-world apps?

© intel, adata



Crucial is working with AMD to have PCIe 5.0 SSDs ready for Ryzen 7000's launch later this year.

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HERTZ SO GOOD

MORE BANDWIDTH FOR YOUR MONITOR.

The DisplayPort 2.0 spec was unveiled by VESA in 2019, but it's only now that the first devices are being certified, in part thanks to ye olde pandemic. The big news with DisplayPort 2.0 is more bandwidth. By a very long way. That means support for higher resolution monitors and higher refresh rates, and less need to use compression or lower colour depth.

The existing DisplayPort 1.4 interface tops out at 32.4Gb/s of raw bandwidth. But only 25.92Gb/s is usable for image data. With the 2.0 spec, that leaps to a headline figure of 80Gb/s. What's more, the DP 2.0 overhead is much lower thanks to moving from relatively inefficient 8/10b encoding with 20 percent overhead to 128/132b encoding with just three percent overhead. So, 77.4Gb/s of that 80Gb/s spec is actually usable and you get three times as much bandwidth as DP 1.4. Nice.

The full speed spec is also known as DP 2.0 UHBR 20, which stands for Ultra High Bitrate and 20Gb/s per lane, making 80Gb/s total with a maximum of four display lanes. There are also UHBR 10 and UHBR 13.5 versions with corresponding bitrates per lane.

In terms of a single monitor, DP 2.0 goes all the way to 15,360x8,460 pixels with HDR at 60Hz and 30 bits of colour per pixel, albeit using Display Stream Compression 1.2a, which VESA claims is entirely lossless. In theory, that makes it visually indistinguishable from a non-compressed image. As for the highest resolution support without DSC, that's 10,240x4,320 at 60Hz without HDR at 80Hz and up to 24bpp.

Of course, as well as more pixels, that bandwidth can be used to support higher refresh rates. If, for example, 4K at 240Hz is your bag, you're going to want some DisplayPort 2.0 action. The snag, as ever, is that you're also going to need new hardware. No surprise, that means a new GPU. We're expecting both AMD's upcoming Radeon RX 7000 series GPUs and Nvidia's RTX 4000 series to support DisplayPort 2.0. Funnily enough, however, it will likely be Intel's upcoming Arc graphics cards that will be the first to offer DP 2.0 support. But we've got a feeling you won't want to touch those with an EM-shielded, fireproof, 10-foot stunt cable, as they are shaping up to be very disappointing by all accounts.

If that's a story for another day, what you might not have bargained for with DisplayPort 2.0 is a special cable. To achieve the full 80Gb/s, DP 2.0 requires an active cable to boost the signal. Fortunately, our understanding is that monitors that require an 80Gb/s link will have a tethered cable or a cable built into the display. So, you probably won't have to pay for it separately. It's also not clear if 80Gb/s support will be on all DP 2.0-compatible graphics cards or if it will be a premium feature. We'll keep our scanners peeled and report back when details are firmed up, but our hunch is that the 80Gb/s interface won't be on all graphics cards.

Meanwhile, if you're wondering about HDMI, for now, there's no news on any updates over the existing 2.1 specifications. DisplayPort 2.0, therefore, will be the weapon of choice for really high-res and high refresh rate computing.

DisplayPort 2.0 will enable future uber-res and refresh rate monitors.

support for the latest Gen 5 version of PCI Express. The socket itself has 16 PCIe 5 lanes for the graphics card and getting on for 64GB/s of bandwidth to the CPU just for graphics. There are also two dedicated four-lane PCIe 5 direct-to-CPU interfaces for connecting storage, providing up to 16GB/s of theoretical SSD bandwidth.

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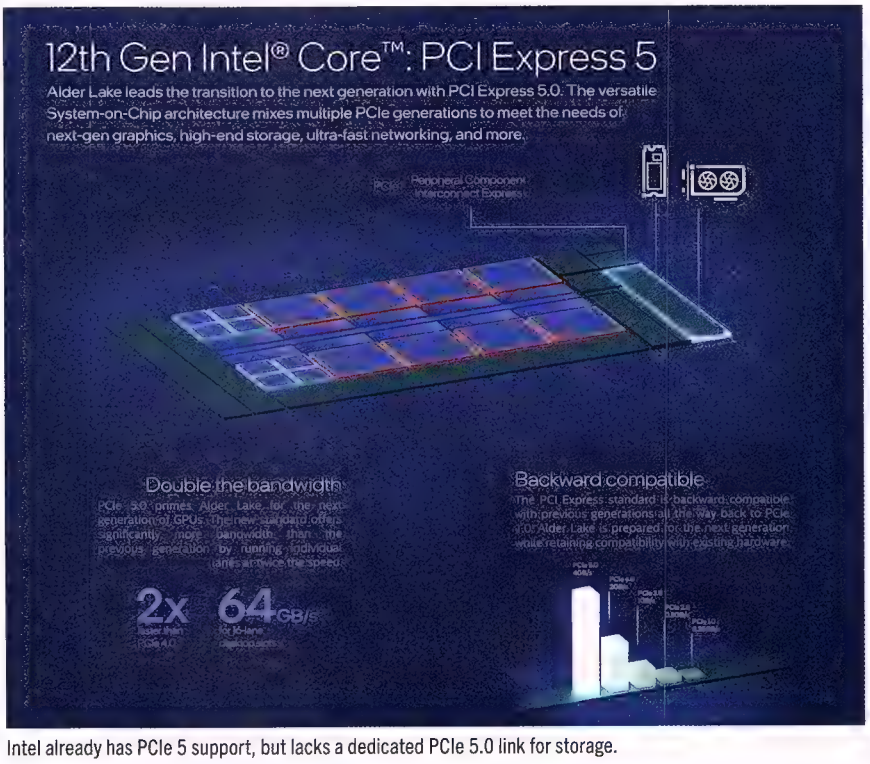
For starters, Raptor Lake will stick with Intel's existing V0 or LGA1700 socket, albeit the fine detail in that area is a little more complicated. LGA 1700 as used by Alder Lake is a 1,800-pin socket but the Alder Lake CPUs only have 1,700 contact pads. For Raptor Lake, it's expected that all 1,800 pins in the V0 socket will be connected. It's quite clever, really, and will allow the 1,800-pin Raptor Lake to be backward compatible with existing 1,700-pin motherboards while increasing pin-out. That said, we don't want to give Intel too much credit for maintaining backward compatibility for a single generation. It's the least it


12th Gen Intel® Core™: PCI Express 5
Alder Lake leads the transition to the next generation with PCI Express 5.0. The versatile System-on-Chip architecture mixes multiple PCIe generations to meet the needs of next-gen graphics, high-end storage, ultra-fast networking, and more.
Peripheral Component Interconnect Express
Double the bandwidth
PCIe 5.0 primes Alder Lake for the next generation of GPUs. The new standard offers significantly more bandwidth than the previous generation by running individual lanes at twice the speed.
2x
64GB/s
Backward compatible
The PCI Express standard is backward compatible with previous generations all the way back to PCIe 1.0. Alder Lake is prepared for the next generation while retaining compatibility with existing hardware.
Intel already has PCIe 5 support, but lacks a dedicated PCIe 5.0 link for storage.

© Dell, crucial,

AMD is bringing DDR5 support to the new Ryzen 7000 CPU family later this year.

can do to ensure some kind of upgrade path for existing Alder Lake motherboards.

But can you expect any platform upgrades from Raptor Lake and its 700 series chipset? In terms of memory, Intel will increase DDR5 native support from DDR5-4800 to DDR5-5600, which will provide a reasonable bump in terms of memory bandwidth. Our understanding is that the Intel 700 series chipset silicon is essentially carried over from the 600 series. However, there might still be some unlocking of what you might call hidden features. The latest, admittedly unofficial, information from Intel indicates that the number of chipset PCIe Gen 3 lanes will be reduced from 16 to eight, but the PCIe Gen 4 lane count will go up from 12 to 20. The 700 series is also expected to get one additional USB 3.2 20Gb/s port for a grand total of five.

Of course, what we'd really like to see is a tweak to the CPU socket connectivity for Raptor Lake. While Alder Lake along with the LGA1700 socket and the 600 series chipset was first to market with PCIe Gen 5, that was limited to the 16-lane graphics link, an arguably redundant feature given there are no PCIe 5.0 graphics cards. Meanwhile, the dedicated M.2 storage interface for the CPU socket was a quad-lane PCIe 4.0 link. Not bad, but not PCIe 5. To be clear, you can run a PCIe 5.0 SSD with Alder Lake. But to do so, you need to use an add-in PCIe card and cut the x16 main graphics link in half to provide access to some PCIe 5.0 lanes. The CPU itself only has those 16 lanes.

The big question, therefore, is whether Raptor Lake will upgrade the direct-to-CPU M.2 interface to Gen 5 spec just as Ryzen 7000, AM5, and AMD's 600 series chipset will deliver. We were hopeful that those additional 100 pads on the bottom of Raptor Lake CPUs were being added at least in part to do just that. Unfortunately, just as we go to press, a leaked internal presentation from Intel shows that the PCIe spec for the Raptor Lake CPU itself is not changing.

If it does not happen for Raptor this year, then it's pretty much a nailed-on certainty that native PCIe 5.0 storage from Intel will arrive next year with the Meteor Lake CPU family and 800 series chipsets. As for what else will arrive with Meteor Lake in platform capabilities, there's little to no information available. But we'd expect even more by way of DDR5 speeds, more USB connectivity, and hopefully a faster link between the CPU itself and the chipset. One other issue to be aware of with Meteor Lake is that, in typical Intel style, it's expected to break socket compatibility and introduce a new LGA1851 platform. So, Raptor Lake will be the only upgrade path for existing Alder Lake-based rigs.

Of course, all of these fancy new motherboard features aren't much good unless there are devices to plug into them. Here we are primarily thinking of storage and, more specifically, the arrival of PCIe Gen 5 SSDs. A little earlier this year, AMD said that it was working with several key players in the storage industry to make sure that the Ryzen 7000 family of CPUs launched alongside SSDs with next-gen PCIe 5.0 interfaces.

AMD reckons that Crucial and parent company Micron will have a PCIe 5.0 drive ready for the Ryzen 7000 launch, which is intriguing given that Crucial hasn't historically been quick to support new PCIe standards. AMD says Gigabyte, MSI, Corsair, and many others will follow shortly thereafter. As for what kind of performance you can expect from PCIe 5.0 SSDs, well, the new protocol allows for a theoretical doubling of performance up to 16GB/s. As ever, protocol overheads reduce that in practice.

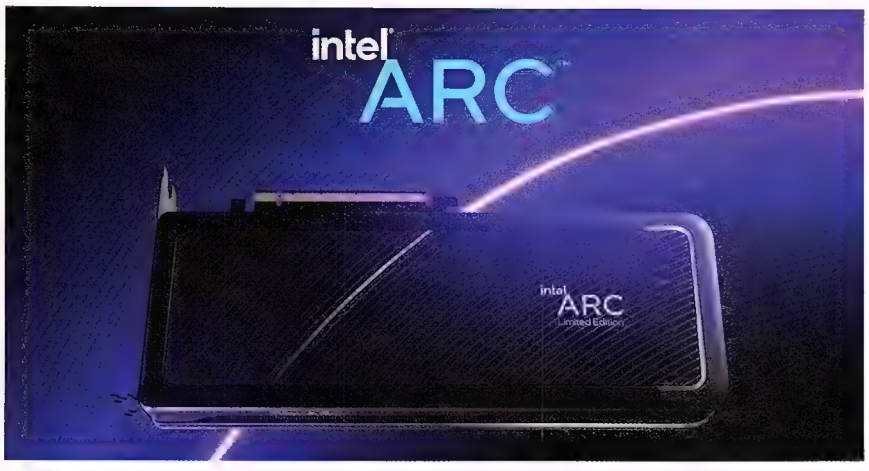
With PCIe 4.0, the fastest drives manage around 7.3GB/s peak sequential performance compared to a maximum theoretical speed of 8GB/s. Early performance figures from SSD makers, including Adata, previewing future PCIe 5.0 models indicate that first-generation PCIe 5.0 SSD read speeds will top out at around 14GB/s, with writes nearer 12GB/s. That is serious, face-melting storage performance.

The slight snag is that the increased PCIe bandwidth will do nothing to improve the current Achilles heel of flash-based SSD performance, namely 4K IOPs (or input-output) performance. That's limited by the inherent characteristics of flash memory and the capability of existing SSD controller chipsets. The 4K random access performance of even the fastest flash SSDs is measured in a few hundred MB/s rather than GB/s. However, when new SSD controller chipsets have delivered support for the latest PCIe standard in the past, IOPs performance has tended to take a step forward, too. So, here's hoping for a particularly big one when PCIe 5.0 SSDs arrive later this year.

Speaking of improving storage IOPs performance, something we're hoping will make an impact even with existing

© corsair, Alienware, intel

Imagine if Alienware's awesome OLED panel could power a gaming laptop via USB-C.



Intel's imminent Arc GPUs are likely to be the first to support the new DisplayPort 2.0 interface. Just don't mention the frame rates...

SSDs in the near future is DirectStorage from Microsoft. It's been available on Microsoft's Xbox games consoles since the launch of the latest Series S and X models. Strictly speaking, it was released for the PC in March this year and so is already available. But its roll-out has been limited so far for PC gaming.

Anyway, the existing issue for games in terms of storage performance involves that perennial IOPs problem. In order to efficiently load only the data actually required for a given game level, such as textures and models, rather than just loading everything available in one big chunk, the data is broken up into lots of tiny packets. This reduces the amount of data that's loaded into the GPU's memory buffers but increases the IOPs load on the SSD.

The Windows OS storage API isn't terribly well optimised for getting the most out of the latest NVMe SSDs when it comes to high IOPs workloads. The existing API incurs numerous extra steps between an application making an IO request and the request being fulfilled by the storage device, resulting in unnecessary request overhead. However, these steps aren't required for every IO request on every NVMe drive on every gaming machine. With a supported NVMe drive and a properly configured gaming machine, DirectStorage will be able to detect up front where these extra steps are not required.

Microsoft says DirectStorage will also reduce per-request NVMe overhead and enable batched many-at-a-time parallel IO requests, which can be efficiently fed to the GPU, and give games finer grain control over when they get notified of IO request completion instead of having to react to every tiny IO completion. Exactly how much impact this will actually have on load times, however, isn't yet clear.

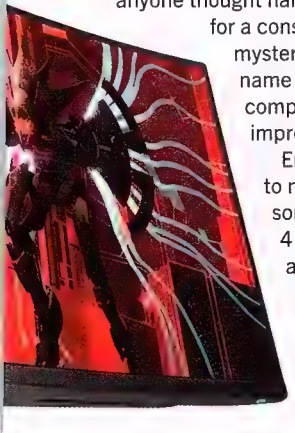
At this year's Games Developer Conference (GDC), the developer of the upcoming action role-playing game Forspoken, Luminous Productions, claimed that DirectStorage would allow game level loads as fast as one second. During the event, the quickest game level load time it demoed was 1.7 seconds, while the same level loaded in around 2.5 seconds running on the standard Windows storage API. So, the benefits aren't as yet hugely dramatic. But we suspect that once game devs really get their heads around DirectStorage, lengthy game-load times will be a thing of the past.

All told, then, the big story for the PC over the next few years is going to be bandwidth. Everything from storage to the CPU socket and display connectors is going to be bursting with the stuff. Those hot new CPUs and GPUs we mentioned right back at the beginning are going to take some serious feeding. Happily, the PC platform should be well up to the task as we move ahead. ■

USB 4 AND SO MUCH MORE

AT LAST, A NAMING SCHEME MERE MORTALS CAN UNDERSTAND.

Increasing the features and bandwidth on offer from the fantastically successful and useful USB, or Universal Serial Bus, interface is always welcome. But for the love of everything that's holy, USB's nomenclature needs an overhaul, too. How on Earth anyone thought names like "USB 3.2 Gen 2x2" are a good idea for a consumer-focused connector is a complete mystery. Indeed, why anyone thought changing the name of USB 3.1, which was fairly comprehensible, to "USB 3.2 Gen 2" was an improvement is even more baffling.



Enter, thank goodness, USB 4, an opportunity to not only increase speed and features but also sort out the idiotic branding. For starters, USB 4 doubles maximum throughput to 40Gb/s. It also simplifies the naming scheme. There will be two versions of USB 4, known as USB 4 20 and USB 4 40, the final numeral indicating the peak bandwidth on offer in Gb/s. Both versions will use the existing USB-C physical connector.

What's more, in an uncharacteristically magnanimous move, Intel essentially handed over all its work on Thunderbolt 3 to the USB Promoter Group, the industry body that defines the USB interface. Long story short, USB 4 incorporates full Thunderbolt 3 functionality and support, and does so without the need to pay any royalties to Intel.

Along with the introduction of USB 4, another imminent USB-related upgrade involves the USB Type-C physical interface specifically. Existing USB-C interfaces are capable of power delivery in parallel to the data connection. The most obvious upside is the ability to connect a laptop to a monitor and have the former charge the latter while the latter drives the image on the former. Once you've gone USB-C with your laptop, you'll never want to go back to a multi-cable solution. It's just so slick.

Currently, USB-C power delivery maxes out at 100W. That's fine for a thin and light, and just maybe for some mid-tier performance laptops. But it's not nearly enough for a beefy gaming laptop with a multicore CPU and a phat GPU. Happily, USB Type-C revision 2.1 fixes that. It ups power delivery support to fully 240W, which should be enough for all but the biggest portable gaming bricks.

There are, however, a couple of catches. Firstly, that 240W spec requires a special cable known as the Extended Power Range cable. These cables will have an identifying emarker and be clearly marked as 50V and 5A capable. So, you won't be able to use any old USB-C cable, which is a pity. The other snag is that 240W is a big old power requirement and it won't be cheap or simple to integrate that into a monitor. Our expectation is that 240W-capable monitors will be both scarce and very expensive.

PC BUILDER

System News

As graphics cards fall, should your credit card fall too? Mark Williams urges caution.

While all graphics cards are returning to RRP, or close to it, AMD Radeon cards are currently seeing the greatest price reductions.

Mark Williams
Mark is an IT professional with a strong interest in voiding warranties.

Nvidia is in a bind. So impactful was the chip shortage of the past few years due to the Covid induced demand, major supply chain shortages and a crypto mining boom, that even while producing more GPUs than they ever had in history, Nvidia along with every other chip designer or manufacturer simply couldn't satisfy the market. Unfortunately, we just had to accept a new reality where cards were hard to get and cost sometimes double what they should.

> "Nvidia seemingly didn't learn from AMD's oversupply mistake during the last crypto boom."

Well, times are finally changing, and the graphics card market has fallen off a cliff with top end cards like the RTX 3090 Ti and RX 6900XT losing as much as $1,000 off their sales price in as little as a month. Not only are card stocks now quite solid (remember when the RTX 3080 10GB was a mythical unicorn card no one could find for the longest time after launch?), there's now so much stock floating around that it's causing a problem for AIBs and vendors. Nvidia seemingly didn't learn from AMD's oversupply mistake during the last crypto boom.

With a new RTX 4000 series originally to be launched in July, old stock needed to be sold off to make way for the upcoming new range, however sales plateaued, and stocks weren't clearing fast enough.

After pleas were made to Nvidia for help, the company eventually came to the rescue in the form of a limited time discount for RTX 3080 12GB and better cards, along with a free game bundle and a shifting of the launch date to September or later and even then, it might only be a single high-end card SKU launch, until into the new year.

This is the current landscape we sit in. Prices have fallen enough to be hovering at or below MSRP. Laughably, as the RTX 3080 10GB wasn't a part of the discount deal, and the faster 12GB model can now be had for the same price or cheaper! These are prices unheard of given the previous few years, but you must remember these are only now falling back to original launch prices. As Jaimie at Leader Computers points out, "now is a fantastic time to upgrade", but remember that Nvidia and AMD are about to drop their new GPU line-ups in the next few months and with reportedly massive performance gains on the way from both, don't get caught up in the fire sales for last generation tech.

Only buy if the price is well below MSRP, otherwise it might be worth waiting for the next generation to upgrade with expectations being that pricing should remain sensible. ■

SHOP TALK

Are you seeing any effects of the apparent glut of RTX 3000 series cards on your business?

Jaimie, Leader Computers:
"From a distribution perspective we are seeing supply of high end Nvidia graphics cards becoming very high due to a drop in demand for blockchain mining, as well as the supply chain somewhat catching up. My advice for anyone looking to juice up the GPU in their gaming rig would be to take advantage of the market conditions, now is a fantastic time to upgrade!"

Richard, Aftershock PC:
"I haven't really seen a glut of RTX 3000 series cards trying to be pushed out into the channel, however I have noticed it with the Radeon GPUs. There has been a pretty strong push to try and get the Radeon cards moving."

Market Watch

A sampling of PC systems available this month

UMART G3 RYZEN 5 5500 RX 6600

$1,599 | tinyurl.com/APC511UMA

This month's cheapest system pick makes too many compromises and as such doesn't offer good value.

The Ryzen 5500 may be one of AMD's latest releases, but with its halved L3 cache vs the 5600, it ends up being on par with the old Ryzen 3600. Serviceable for sure but it'll be a constant drag on performance. The RX6600 GPU is unbeatable currently in this price tier so no complaints there. 1440p gaming will be easy and preferred to keep the bottleneck off the weak CPU. The memory is another major negative, at just 2666MHz (instead of the preferred 3200MHz) it'll further hold back the already weak CPU. The sole 250GB SSD will get filled up quickly and the 450W power supply is anaemic and will cause issues for any decent upgrades later.

CPU: AMD Ryzen 5500; **Cooler:** OEM; **Motherboard:** Asus Prime B550M-K; **Graphics:** Asus Radeon RX 6600 Dual 8GB; **Memory:** 16GB DDR4 2666MHz; **Storage:** Crucial P2 250GB M.2 NVMe SSD, 1TB HDD; **Power Supply:** Corsair CV450 450W; **Case:** Azza Elise.

MWAVE RESPAWN NINJA THRILLER

$1,699 | tinyurl.com/APC511MWV

At just $100 more than the Umart system, this offers miles better value and longevity. The 650W power supply for a start means upgrades are at least feasible. The 1TB SSD is far more capacious and useful for gamers with large game libraries.

The CPU is probably the best budget choice for gamers now too, offering Ryzen 5600X levels of performance at a cheaper price. Paired with the superb choice of the RX6600 graphics card this system is a fantastically well-rounded system that has a decent third-party cooler and even some speedy RAM. A great value choice.

CPU: Intel Core i5 12400F; **Cooler:** Deepcool Gammaxx 400 XT; **Motherboard:** Asus TUF Gaming B660M-Plus WiFi D4; **Graphics:** Asus Radeon RX 6600 Dual 8GB; **Memory:** Adata XPG Spectrix D60G 16GB DDR4 3600MHz; **Storage:** Crucial P2 1TB M.2 NVMe SSD; **Power Supply:** BeQuiet! Pure Power 11 FM 650W; **Case:** BeQuiet! Pure Base 500.

NZXT STREAMING PC

$2,399 | tinyurl.com/APC511NZX

Tipping in at $800 more than the Mwave system, the big-ticket item is the move up to the RTX 3060 Ti graphics card which offers between thirty to forty percent more raster performance than the RX 6600 and eats up about half of the price gap. So where does the rest of the $400 price difference go?

We have an AIO water cooler on the CPU, always great for looks but mostly unnecessary with this calibre of processor. The case costs a little more as does the CPU and assuming some good-branded parts are used for the motherboard, RAM and SSD it all starts to make sense.

Aside from the technically unnecessary (though aesthetically pleasing) AIO this looks to be a solid system for more dedicated gamers.

CPU: AMD Ryzen 5 5600X; **Cooler:** Nzxt Kraken 120; **Motherboard:** B550-based; **Graphics:** GeForce RTX 3060 Ti; **Memory:** 16GB DDR4 3333MHz; **Storage:** 1TB NVMe SSD; **Power Supply:** Nzxt C650 Bronze; **Case:** Nzxt H510 Flow.

JW COMPUTERS GMR AMETHYST 3060 TI

$2,459 | tinyurl.com/APC511JWC

Sliding in as this month's dearest system with a $60 premium, is it worth the extra money? While the 5600 (non-X) CPU in games basically acts the same as the 5600X, it is technically slower which will marginally show in any productivity workloads. There is faster memory here which Ryzen likes and a 240mm AIO cooler which should show a benefit to temperatures and thus boost clock longevity. The larger 750W power supply will support more substantial upgrades.

The big negative of this system is the sole 500GB SSD. At this price point it's disappointing to see. With the same GPU on offer, it's roughly the same amount of gaming performance on offer as the Mwave system. Overall, it's broadly better so the extra cost appears to be worth it, however, temper it against having half the SSD capacity if considering this.

CPU: AMD Ryzen 5 5600; **Cooler:** MSI MAG Coreliquid 240R V2 AIO; **Motherboard:** MSI B550-A Pro; **Graphics:** GeForce RTX 3060 Ti 8GB; **Memory:** G.Skill Trident Z Neo RGB 16GB DDR4 3600MHz; **Storage:** Samsung 970 EVO Plus 500GB M.2 NVME SSD; **Power Supply:** MSI MPG 750W; **Case:** Thermaltake V250.

PC BUILDER

Blueprints

Value- and performance-driven hypothetical builds

"After a recent overhaul, our budget Intel build sees only one change to its lineup this issue. "

BUDGET

A perfect balance between price and peformance.

After a recent overhaul, our budget Intel build sees only one change to its lineup this issue. There's been a $21 fall in price for the 500GB MSI Spatium M450 SSD, which now features in both PCs and it's a solid component.

The G.Skill Ripjaws V sticks held steady in price, and while the CL16 model is available if you look around, it's more common to find the nearly as good CL18 sticks. On the motherboard front there's been little movement across the market. The Asrock B660 Pro RS is still a great pick-up at this price. Our Gigabyte Eagle OC has continued to fall (though there's a lot of variance between shops), which is a pleasant surprise – we're as shocked as you are to see falling GPU prices! The 8GB model is getting harder to find, with the better 12GB more common now just on $600, so we're switching to that.

On team AMD, our MSI Mech Radeon RX 6600 XT is still around $460 and that's a good price. We also get a welcome drop in the price of our CPU. The AMD Ryzen 5 5600X is now around $30 cheaper than before. It's a brilliant budget CPU, so how can we complain?

So, unusually, the AMD machine remains the same this month. We keep the 16GB Corsair Vengeance LPX CL16 RAM kit as this still packs a punch running at 3600MHz. Nothing changes on the motherboard, it still works well in this build, piecing all the components together. More importantly, it remains at the same low price point.

AMD INGREDIENTS

Part		Price
Case	Corsair 4000D Airflow	$120
PSU	550W Corsair CV550 80+ Bronze	$75
Mobo	Gigabyte B550 Aorus Elite AM4	$199
CPU	AMD Ryzen 5 5600X	$299
GPU	MSI Mech Radeon RX 6600 XT 8GB	$460
RAM	16GB (2 x 8GB) Corsair Vengeance LPX CL16 @ 3600MHz	$110
SSD	500GB MSI Spatium M450 PCIe 4.0 M.2 SSD	$99
HDD	4TB Seagate Barracuda	$120
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$1,542

INTEL INGREDIENTS

Part		Price
Case	Corsair 4000D Airflow	$120
PSU	550W Corsair CV550 80+ Bronze	$75
Mobo	Asrock B660 Pro RS LGA 1700	$189
CPU	Intel Core i5-12600	$429
GPU	Gigabyte Eagle OC GeForce RTX 3060 8GB	$599
RAM	16GB (2 x 8GB) G.Skill Ripjaws V CL16 @ 3600MHz	$110
SSD	500GB MSI Spatium M450 PCIe 4.0 M.2 SSD NEW	$99
HDD	4TB Seagate Barracuda	$120
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$1,801

"We stick with the more powerful Z690 chipset in our Asrock Pro RS and keep the Intel Core i7-12700F paired with it – prices for this powerful duo remain the same."

MID-RANGE

A game-ready machine that can also handle demanding work.

The AMD mid-range build only sees a change in CPU coolers, there are shifts in prices across the board. The EVGA SuperNova going up by $20. This 750W PSU is also seen in the Intel mid-range build and has an 80+ Gold rating. One of the main price changes is on our Asrock Radeon RX 6800 XT Phantom Gaming D. It has gone up by around $150 but is still one of the best cards to have in our AMD mid-range PC. The AMD Ryzen 7 5800X remains steady, but is now cooled by a different CPU cooler, the Cooler Master Masterliquid ML240L RGB V2. This finds its way into the Intel machine too, with a price of just $89. Intel's i7-12700F has crept up in price by $20.

For the rest of the Intel machine, we've swapped out the Asus TUF Gaming GeForce RTX 3070 8GB with an MSI Ventus 2X OC GeForce RTX 3070 8GB. Not only is it cheaper, but this 8GB GPU is also now priced similar to RTX 3070 LHR cards, so is a more sensible choice. Both our GPUs are in stock, which means you can avoid the hefty street prices. Other than this GPU change, both mid-range builds receive the same changes with the Cooler Master Masterliquid ML240L RGB V2.

We stick with the more powerful Z690 chipset in our Asrock Pro RS and keep the Intel Core i7-12700F paired with it – prices for this powerful duo remain the same. We saw a rise in price for the Corsair Vengeance RGB RT CL16 RAM, but it still has our recommendation. The Corsair MP600 Pro LPX SSD is still around $220 and this 500GB solid-state drive is a powerful storage solution. With prices altering slightly across most components, the overall totals remain similar to last time. We're just relieved they're no longer skyrocketing.

AMD INGREDIENTS

Part		Price
Case	Lian Li PC-011-Dynamic	$209
PSU	750W EVGA SuperNova 750 G5 80+ Gold	$149
Mobo	Asrock X570 Steel Legend AM4	$299
CPU	AMD Ryzen 7 5800X	$449
Cooler	Cooler Master Masterliquid ML240L RGB V2 NEW	$89
GPU	Asrock Radeon RX 6800 XT Phantom Gaming D 16GB	$1,099
RAM	32GB (2 x 16GB) Corsair Vengeance RGB RT CL16 @ 3600MHz	$279
SSD	500GB WD Black SN850 NVME M.2 PCIe 4.0 SSD	$139
HDD	4TB Seagate Barracuda	$120
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$2,892

INTEL INGREDIENTS

Part		Price
Case	Lian Li PC-011-Dynamic	$209
PSU	750W EVGA SuperNova 750 G5 80+ Gold	$149
Mobo	Asrock Z690 Pro RS LGA 1700	$299
CPU	Intel Core i7-12700F	$519
Cooler	Cooler Master Masterliquid ML240L RGB V2 NEW	$89
GPU	MSI Ventus 2X OC GeForce RTX 3070 8GB NEW	$829
RAM	32GB (2 x 16GB) Corsair Vengeance RGB RT CL16 @ 3600MHz	$279
SSD	500GB Corsair MP600 Pro LPX M.2 PCIe 4.0	$220
HDD	4TB Seagate Barracuda	$120
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$2,773

"Although these Turbo builds are more focused on performance over cost savings, we can't help but enjoy it when a component goes down in price."

TURBO

The maximum PC.

With our Turbo build, we have some interesting alterations, mainly for the Intel rig. On the AMD PC, our newly added Gigabyte X570 Aorus Elite WiFi motherboard saves us $50 from the last issue, though it appears stocks are dwindling. Although these Turbo builds are more focused on performance over cost savings, we can't help but enjoy it when a component goes down in price. On the flip side, the EVGA SuperNova P6 80+ Platinum power supply is proving difficult to find, so we're replacing it with the same 850W Corsair HX850 80+ Platinum as in the Intel build. Again, we're glad that the GPU prices have hardly altered, and while it'd be nice to see some larger price reductions, we will take anything we can.

There have been some substantial changes this time for the Intel turbo machine. The 6TB WD Blue 5400 HDD has fallen by $6. Both builds have been hit by a small increase as they contain the same HDD, but there's better news elsewhere as we are happy to see that the Intel i9-12900K is now $639 rather than the previous $819. This lightning-quick processor is perfect for gaming with its hybrid architecture and simple one-click overclocking feature.

The 12900K now sits on a different motherboard from last time, an Asus TUF Gaming Z690-Plus WIFI. It has the all-important Z690 chip and DDR5 support, and saves us $130. One of the most pleasing changes we have made is the switch from an RTX 3090 to a Ti variant, specifically the MSI GeForce RTX 3090 Ti Gaming X Trio 24GB, which is $400 less than last month's non-TI model. Though, more than anything, just looking below highlights the massive difference between AMD and Nvidia GPU pricing at the moment. It's crazy. Is ray tracing really that valuable?

We've also paired this with some slightly faster and cheaper RAM. The G.Skill Ripjaws S5 sticks run at 5600MHz compared with the 5200MHz speeds of the Corsair Vengeance sticks before them.

AMD INGREDIENTS

Part		Price
Case	Phanteks Enthoo Pro 2 Tempered Glass	$220
PSU	850W Corsair HX850 80+ Platinum NEW	$270
Mobo	Gigabyte X570 Aorus Elite WiFi	$355
CPU	AMD Ryzen 9 5950X	$799
Cooler	CoolerMaster MasterLiquid ML360 Illusion 360mm	$189
GPU	Asrock Radeon RX 6900 XT Phantom Gaming D 16GB	$999
RAM	64GB (2 x 32GB) G.Skill Trident Z RGB DDR4 @ 4000MHz CL18 NEW	$630
SSD	1TB WD Black SN850 M.2 PCIe 4.0	$240
HDD	6TB WD Blue 5400 HDD	$189
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$3,951

INTEL INGREDIENTS

Part		Price
Case	Phanteks Enthoo Pro 2 Tempered Glass	$220
PSU	850W Corsair HX850 80+ Platinum	$270
Mobo	Asus TUF Gaming Z690-Plus WIFI DDR5 LGA 1700 NEW	$389
CPU	Intel Core i9-12900K	$639
Cooler	MSI MAG Coreliquid C 78.73 360mm NEW	$159
GPU	MSI GeForce RTX 3090 Ti Gaming Gaming X Trio 24GB NEW	$2,399
RAM	64GB (2 x 32GB) G.Skill Ripjaws S5 DDR5 @ 5600MHz NEW	$589
SSD	1TB Gammix Gaming S70 M.2 PCIe 4.0 SSD	$239
HDD	6TB WD Blue 5400 HDD	$189
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$5,153

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QUICK TIPS

The problem solvers

The APC team field problems across the spectrum of devices and software. Learn a new trick or fix you can use.

Tighten privacy

I do worry about govt data collection, in particular the US FBI, even though I'm Australian it scares the heck out of me. They aren't just spying on people, they act on it, too. Thousands of arrests are made every year due to the FBI or other alphabet-soup government agencies invading our privacy. Hacking and ransomware attacks are at an all-time high.

My suggestion to you is to have a full feature on privacy and how to keep your data secure. I believe Nick Peers has done this before, maybe a few years ago now, but he did a great job. It could cover how simple it is to have your data monitored (or stolen) if you're not being careful, and how to prevent it from happening by using VPNs, TOR, encryption, and any relevant Linux distros.

> "Thousands of arrests are made every year due to the FBI or other alphabet-soup government agencies invading our privacy. "

This is such an important issue, it should be covered annually to keep everybody up to date with what is out there to keep data secure and your privacy intact.

Dillon Kenneth Wicks

APC responds: We covered this important topic in the last issue (510) of APC (which we should say went onsale after receiving Dillon's email), and will certainly revisit it often. In the meantime, here's some quick advice on what tools can – and can't – do to protect your security and privacy.

First, make sure you have strong up-to-date anti-malware software to keep malware off your PC. Ensure your entire network – including your router– is protected. In the case of your router, disable any remote administration options and change the default password if you haven't already. Also, check your router's firewall is enabled and that UPnP is disabled to prevent drive-by hackers from discovering a backdoor to your system. Finally, you should visit **https://routersecurity.org/testrouter.php** to perform a series of tests to verify how secure you are.

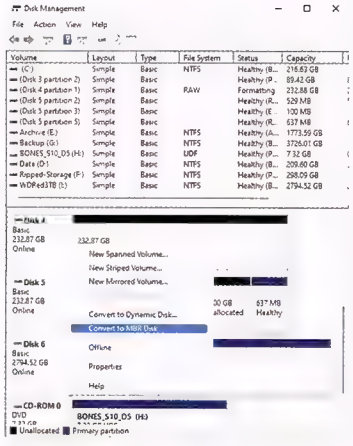
That deals with inbound threats, but how do you protect your own legitimate excursions onto the internet? Your first line of defense should be a VPN – this not only scrambles your data across wireless networks (secure or otherwise), but it also masks your internet activity from your own ISP as well as your true location from any servers or sites you communicate with. Choose a VPN headquartered outside the 14 Eyes surveillance network – see **www.techradar.com/vpn/best-free-vpn** for a list of the best free ones to try.

Note that VPNs mask your data during transit from your ISP to the VPN's own server, but from that point on it's decrypted and visible – you still leave a footprint. In terms of encrypting your actual internet traffic, you need to make use of additional tools, from a browser such as Tor (**www.torproject.org**), which scrambles all your data to help evade trackers, to a trusted end-to-end encrypted messaging application, such as Signal (**https://signal.org**). You shouldn't even trust your cloud storage provider's own encryption tools to keep your data safe – wrap data in another encrypted layer such as that offered by Cryptomator (**https://cryptomator.org**), so even if your cloud provider hands over your encryption keys to the authorities, they'd still only find scrambled data awaiting them.

As well as wrapping yourself in multiple layers, consider what activity you do perform on the internet. You should assume you're still being monitored and act accordingly.

Niche browser tip

Browsers come up regularly in the mag, and from time to time there's a head-to-head comparison of popular ones. I'm wondering what you guys think about my browser of choice: Brave. Tor is built-in, there's a rewards system that allows you to earn crypto as you browse, ads are blocked by default, and more. It's fast and reliable, based on the open-source Chromium browser from Google. I like it more than any browser I've tried in the past, and don't plan on switching anytime soon. It's not as popular as the big dogs but has a devout following. I'm interested in what you guys think about it.



Initialise SSDs as MBR for use with your TV.

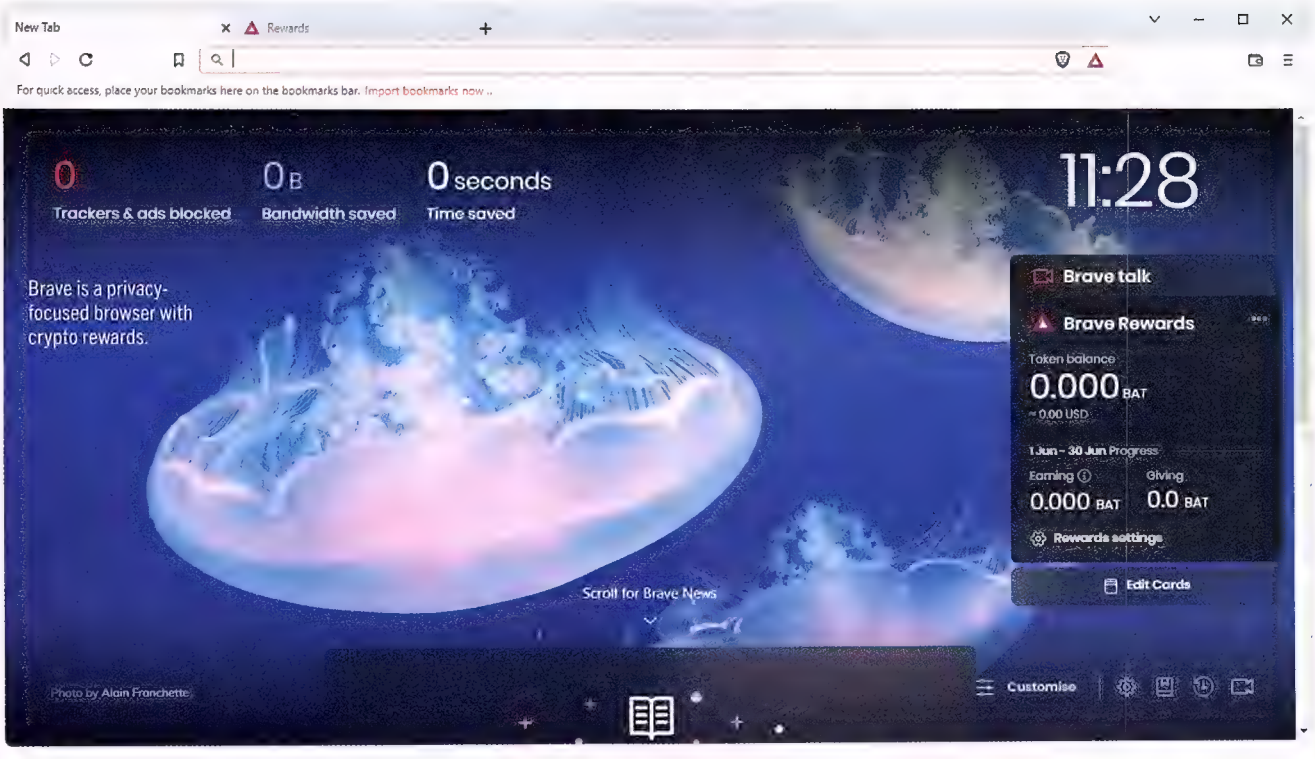
Mark Lonnemann

APC responds: There are dozens of browsers, all aimed at different markets and niches, but when it comes down to it, you're basically choosing between variations on three browser engines. The majority – including Brave – are powered by Google's Blink, while Firefox (and variants, such as Waterfox) continues to plow its own furrow with its open-source Gecko engine. The third option – WebKit – is Apple's entry into the market (little-known fact: Google's Blink developed as a fork from WebKit).

APC has all major browsers installed on his PC for one reason or another but defaults to Firefox. Blame his obsession with supporting the 'little guy'. The downside is that not all sites work well with Gecko, so as a backup he usually reverts to Edge, Opera (when wanting a quick-and-dirty VPN), or Vivaldi (because it's just so damn configurable).

It's clear you've done your homework on Brave, and if the browser does what you need, there's no reason to care what we think. Our colleague tech guru and self-confessed "Firefox loyalist"

© Microsoft



Jonni Bidwell, said: "Brave really is a better browser, even if you don't care about its rewards program. Well worth your basic attention." This verdict was backed up by Shashank Sharma, who later placed Brave top of his list, beating the likes of Opera and Vivaldi across a range of metrics, including ease of use, privacy, security, and performance.

Long story short: Your recommendation, backed up by our Linux experts, means *APC* is going to add another Chromium-based browser to our installed list. Maybe it's time Edge got bumped for something a little Brave(r)?

SSD not detected

I was intrigued by your suggestion of hooking up a Samsung T5 ultra-portable SSD to my TV in place of a flash drive to record TV shows. Unfortunately, I can't get my TV to recognise the drive, despite having formatted it as FAT32 as per the TV manual's instructions. Am I missing something obvious?

Georges Galindo

APC responds: We missed out on one key bit of information when recommending SSD drives for TVs – you may need to reconfigure the drive to use the MBR partition table instead of the default GPT. Note that MBR-partitioned drives can only access the first 2TB on any drive, but as T5 drives currently max out at 2TB, that won't be a problem.

You can reinitialise the drive in Windows – this is a completely destructive process, so if there's any data on the drive, copy it off first. Then open Disk Management (press Win-R, type "diskmgmt.msc" and hit Enter). Locate your T5 drive, right-click any volumes set up on it, and delete the lot to leave only "unallocated" space. Now right-click to the left of the unallocated space (namely where it says Disk 'x', Basic) and choose "Convert to MBR Disk."

You don't get confirmation this has happened, so right-click again and choose "Properties > Volumes tab" to verify the partition style is set to "Master Boot Record (MBR)." Click "OK," right-click inside "Unallocated," and choose "New Simple Volume," then follow the prompts to initialise the disk, making sure "File system" is set to FAT32 or one that's compatible with your TV.

Once done, you should be able to plug the drive into your TV and use it both to record and play video.

Portableapps glitch

I use **PortableApps.com** to run as many apps as possible without installing them on my hard drive. I love the way it works with most portable apps, not just those you can install through the platform.

However, I've run into a problem: While I can copy most program folders into the "PortableApps" folder, then click "Apps > Refresh App Icons" to get them to pop up in the PortableApps launcher, some apps don't appear. I've discovered these are app executables stored inside subfolders within their own parent folder. Is there a way to get PortableApps to recognise these programs, too, so that I can file them into the main launcher?

Frederick P Legault

APC responds: It's rare for this problem to occur – if you install CCleaner Portable manually (see **www.ccleaner.com/ccleaner/builds**), for example, you'll run into this issue. Luckily, there is a fix but it's a convoluted one.

First, browse to the CCleaner folder and create a subfolder inside called "app". Open this and create a further subfolder called "appinfo". Finally, navigate into this folder, right-click and choose "New > Text Document" to create a blank text file in your text editor.

Type the following lines:

```
[Format]
Type=PortableApps.comFormat
Version=0.9.8

[Details]
Name=CCleaner
Publisher=Piriform
Homepage=ccleaner.com
Category=Cleanup
Description=CCleaner

[Version]
PackageVersion=6.00.9727
DisplayVersion=6.00

[Control]
Icons=1
Start=\x64\CCleaner64.exe
ExtractIcon=\x64\CCleaner64.exe
```

Fill in the [Details], [Version], and [Control] tabs with information from your portable app – when using [Control] to specify the app location (Start=) and its icon (ExtractIcon=), your app's parent folder is considered the 'root', so make all paths relative to this.

Save the file as "appinfo.ini" (make sure it has the .ini file extension, not .txt). Then reload the PortableApps launcher and you should see your app under your chosen category, with the correct icon and details. Click it to verify it launches; if anything is amiss, reopen "appinfo.ini" to review your edits. ■

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WINDOWS

Customise your Windows 11 desktop

Make it yours, with some personal style and functionality.

■ YOU WILL NEED **Rainmeter** Download this free tool from **www.rainmeter.net**. **Cairo** Visit **https://cairoshell.com** to download this handy app. **WinDynamic Desktop** Grab this gratis tool from **https://github.com/t1m0thyj/WinDynamicDesktop**.

Are you bored with your Windows desktop? Perhaps the new Windows 11 refresh doesn't quite grab you, or maybe you've decided to cut loose after years of making do with various shades of grey. The good news is that your desktop doesn't have to remain staid and stale, and we've got all the tips and techniques you need to not only make it more attractive but more functional, too.

We open with a simple facelift using Windows' own tools – a wallpaper change, a colour scheme update, and a look at combining all your customisations into a single theme. Not radical enough? Check out the box on page 84 for a tool that can transform your desktop into something more dynamic, with a background image that magically updates as the sun rises, sets, and finally disappears behind the horizon.

If aesthetics aren't your thing, we also introduce you to a desktop "skinning" tool called Rainmeter, which enables you to place a series of useful information tools – from clocks and to-do lists to system resource meters – on your desktop. And last, but by no means least, we introduce you to an even more radical tool, Cairo, which helps you change the way you use your desktop, transforming it into a tool that's as practical as it's pretty.

Simple tweaks

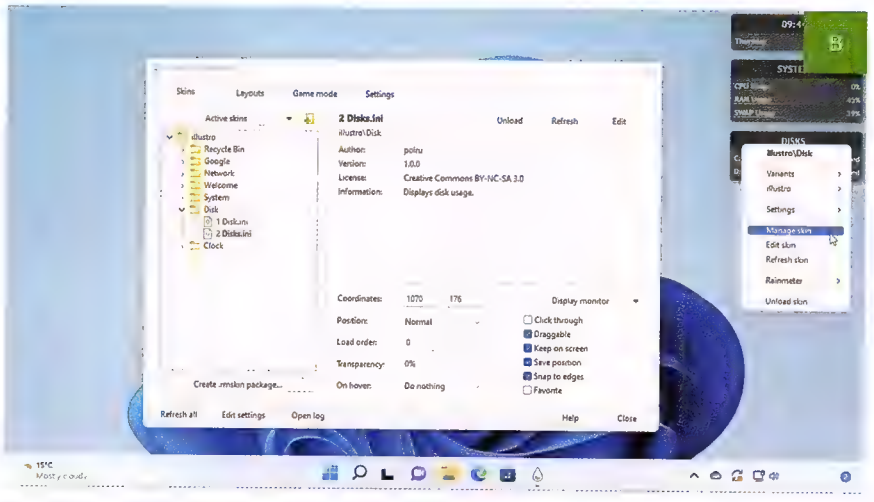
If you're just starting out in the world of desktop customisation, you'll find Windows offers many options within its own Settings app – right-click the desktop and choose "Personalise" to see what's available. You're shown a list of themes, which are a collection of wallpapers, colour schemes, sounds, and cursors. More on that in step two.

For now, focus on the sections below these, starting with "Background". Select this and you can set your wallpaper one of four ways using the drop-down: Picture, Solid colour, Slideshow (choose a folder of images on your PC), or Windows spotlight, which displays a series of landscapes handpicked by Microsoft.

By default, when you select a new background, you should find your Taskbar and other desktop elements change colour to match the wallpaper – to change this behavior, select "Colours" instead. You'll see options to switch between dark and light mode (Windows enables you to specify different settings for Windows dialogs and apps). You'll also see a "Transparency effects" switch – flick this on and when your dialogs pass over a strongly coloured background (such as your wallpaper), you'll see a hint of that colour peeping through.

Beneath this is the "Accent colours" switch – if it's set to "Automatic," the basic colours of dialog boxes, the Taskbar, and other Windows elements are determined by the colour scheme of your desktop wallpaper. If you'd rather set these yourself, set the drop-down menu to "Manual" and experiment with the various colours displayed beneath (if they don't fit the bill, scroll further down, and click "View colours" to choose from the entire Windows palette).

One final tip: If you want to change the colour of the Taskbar, you need to switch from Light mode to Dark or Custom. Once done, the "Show accent colour on Start and Taskbar" switch becomes available, and it reflects the other dialogs.

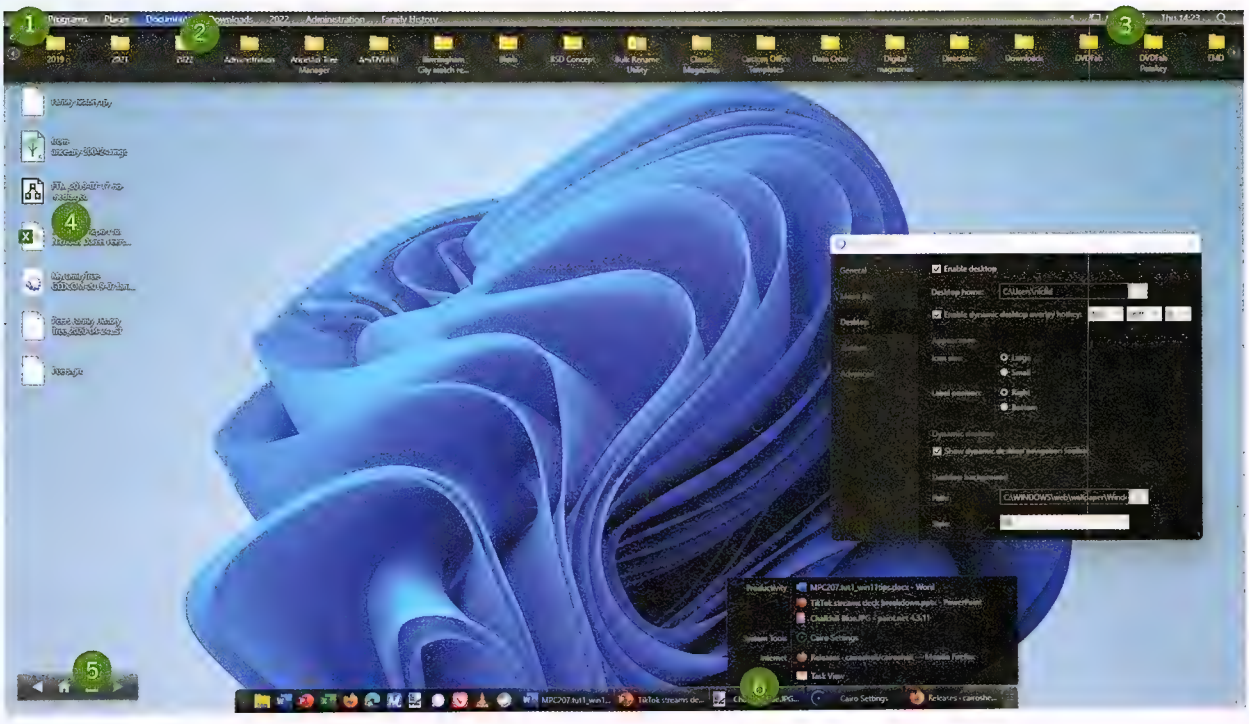


Work with Themes

If you're short of inspiration for your new-look desktop, let Windows take the strain by choosing a pre-set theme. You'll see a small collection on the main "Personalisation" page – click one and your wallpaper and colour scheme should update automatically to reflect the new theme.

To access additional themes as well as controls for creating your own, click "Themes" followed by "Browse themes" to find other themes to try. These are installed through the Windows Store and you can find dozens of alternatives online. Click "Get," wait for a theme to be downloaded and installed, and click "Open" to return to the "Themes" section of Settings, where the new theme should be available in the list.

If you'd like to go further, why not craft



CAIRO IN ACTION

1. CAIRO MENU
Click here to open Cairo's main menu, where you can configure Cairo, access system settings, and shut down Cairo (or your PC).

2. STACKS
Contains shortcuts to Programs (separated into customisable categories), Places (shortcuts to key user folders such as "This PC"), and Folder Stacks, frequently accessed folders you add by dragging to the bar.

3. NOTIFICATION AREA
Cairo moves the Taskbar notification area to the menu bar, where it resides with a handy Search tool that can be used to search files, folders, system settings, and more.

4. DYNAMIC DESKTOP
Your desktop becomes – in Cairo's words – an "interactive file browser." Simply double-click a folder to view its contents directly on the desktop itself.

5. NAVIGATION TOOLBAR
This floating toolbar enables you to move between folders, jump to a new folder, and return to your designated home folder.

6. CAIRO TASKBAR
Cairo's Taskbar is a more focused version of Windows' own. Next to the Quick Launch area, open windows are sorted by category. Click the Task List button for a categorised list and access to Windows' own Task View.

your own desktop theme from scratch? At the top of the "Themes" dialog, you'll find four shortcuts to each component – click these in turn to make your choices, then return to this screen to click "Save," and give your theme a name. It then appears in the list, ready for selection.

If you're looking to apply more radical customisations to your desktop's look and feel, you need a program such as WindowBlinds (US$9.99 after a 30-day trial, **www.stardock.com/products/windowblinds/**). This gives you more control over the appearance of elements such as the Start menu, Taskbar, dialog boxes, and more.

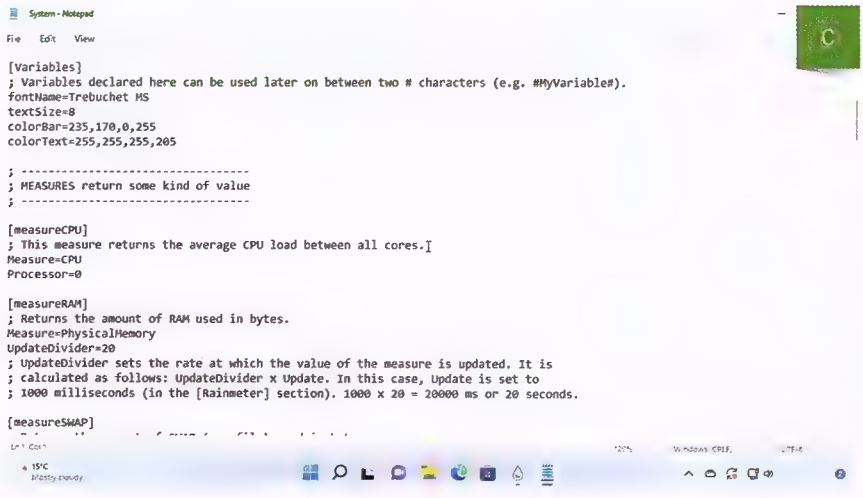
Rainmeter
Is your desktop working hard enough for you? If the answer is no, Rainmeter (**www.rainmeter.net**) could provide the answer. This popular and well-established open-source tool basically enables you to "skin" your desktop by overlaying customisable widgets on top of it. These widgets can display all kinds of useful information, and some are even interactive – for example, a widget enables you to search Google directly from your desktop. Somewhat confusingly, Rainmeter describes its widgets as "skins", and collections of widgets as "suites". For the purposes of clarity, we're sticking with widgets and skins.

Download the program and run through the installer – for the most part, the defaults should be fine, but pay attention to the "Launch Rainmeter on startup" option if you're not sure you'll want to use Rainmeter all of the time.

Once installation is complete, leave "Run Rainmeter" checked and click "Finish". Rainmeter ships with a single skin – Illustro – and enables four of its seven available widgets by default. In the center of the screen, you'll see a Welcome panel with some information and links to further information, while three further widgets – Clock, System, and Disks – appear in the desktop's top-right corner [**Image A**].

> "If you're short of inspiration for your new-look desktop, let Windows take the strain by choosing a pre-set theme."

Manage skins
These widgets are all floating, so can be moved by dragging and dropping. They are made up of two basic elements: Measures, which gather information from various sources, and meters, which determine what the widget displays and its basic structure (including frames, backgrounds, images,


System - Notepad
File Edit View
[Variables]
; Variables declared here can be used later on between two # characters (e.g. #MyVariable#).
fontName=Trebuchet MS
textSize=8
colorBar=235,170,0,255
colorText=255,255,255,205
; ----------
; MEASURES return some kind of value
; ----------
[measureCPU]
; This measure returns the average CPU load between all cores.
Measure=CPU
Processor=0
[measureRAM]
; Returns the amount of RAM used in bytes.
Measure=PhysicalMemory
UpdateDivider=20
; UpdateDivider sets the rate at which the value of the measure is updated. It is
; calculated as follows: UpdateDivider x Update. In this case, Update is set to
; 1000 milliseconds (in the [Rainmeter] section). 1000 x 20 = 20000 ms or 20 seconds.
[measureSWAP]

charts, buttons, and so on).

Each widget provides a mixture of information and links to other elements – for example, not only does System display your current CPU, RAM, and SWAP usage, but if you click its heading, it opens Task Manager. Similarly, Disks displays the C and D drives, and clicking either opens the relevant drive in File Explorer.

Widgets can be moved around the screen simply by dragging and dropping, or you can right-click them to bring up a pop-up menu offering additional options. Choose "Manage skin" to bring up the "Manage Rainmeter" dialog [**Image B**], which is also accessible via Rainmeter's Taskbar notification area icon. Here you'll see you can precisely position the widget using exact coordinates, choose a different display to show it on, set its transparency level, and even use the "Position" drop-down menu to "layer" it in relation to other widgets and desktop elements.

The dialog lists all available widgets for the current skin, including those not yet visible. In the case of Illustro, there are additional widgets to display the state of your Recycle Bin, provide network stats, and offer a quick and easy way to search Google without leaving your desktop. Simply expand the relevant folder, select the .ini file, and click "Load" to show the widget; click "Unload" to remove any unwanted ones from the screen (or just right-click the widget and choose "Unload skin").

Edit widgets

You'll notice an "Edit skin" option appears both on the pop-up menu and within the "Manage Rainmeter" dialog for each widget. Selecting this opens the widget's underlying .ini file in your text editor – if nothing happens after clicking "Edit," switch to the "Settings" tab, and verify the path to the Editor listed– change this to C:\Windows\System32\notepad.exe or click "..." to select your own text editor if necessary.

You'll see the text file contains pretty much everything you need to know about the widget in question, and follows a logical format:

[Section]
Key=Value

Choose one of the default widgets and you'll see plenty of descriptive information to help you understand what keys do what [**Image C**], although much of it is self-explanatory – for example, X and Y refer to coordinates, while W and H determine an element's size, and Text is what you see on screen.

After making changes, choose "File > Save," then switch back to the "Manage Rainmeter" dialog and click "Refresh." How much information is defined in the .ini file determines how configurable a widget is – some authors provide more options than others. You may find some widgets, such as Disk, come with more than one .ini file – this enables you to configure variations (in the case of Disk, the widget either shows the capacity of a single drive or two drives), but note that only one .ini file can be loaded for any individual widget at any one time.

For more on skins, visit **https://docs.rainmeter.net/manual/skins/** to work your way through Rainmeter's extensive documentation and reference guide.

Get more skins

There's no need to design your own skins and widgets from scratch – there are literally hundreds of skins out there,

GET A DYNAMIC DESKTOP

Are you jealous of macOS's dynamic desktop? It works by updating the background wallpaper periodically depending on the time, offering different variations on the same image to reflect sunrise, daytime, sunset, and finally night.

You can emulate this feature on your Windows desktop with the free and open-source WinDynamicDesktop (**https://github.com/t1m0thyj/WinDynamicDesktop**). Download the portable app to have a play, then use the installer to make it a permanent part of your system if you like what you see.

After launching for the first time, enter your location so the desktop updates dynamically with your time zone and seasons. Click "OK." From here you're shown a selection of wallpapers with dynamic previews – most will be familiar to macOS users.

Click "Download" then "Apply" to switch your wallpaper to one of those included with the program, or click "Get more themes online" to access over 200 themes online, most of which are free (others typically cost just a dollar or two). Once downloaded, extract the .ddw file and click "Import from file" in WinDynamicDesktop to add it.

You'll find more options by right-clicking the WinDynamicDesktop Taskbar notification area – including the ability to change the lock-screen image and shuffle your theme randomly on a daily basis.

sporting an almost infinite array of designs. These are organised into repositories, of which there are five major ones for Rainmeter – you'll find links to them all at **www.rainmeter.net/discover/** but the biggest one by far is DeviantArt's – click the "Skins" link under "Gallery Folders" to browse by category. When reviewing results, scroll down to look for a link to the suite or skin's own page, often hosted at GitHub.

You'll notice many of these skins have their own unique look and feel. For example, the Monterey Rainmeter suite (see **https://github.com/creewick/MontereyRainmeter**) has a series of widgets in the style of macOS [**Image D**].

Skins are packaged as .rmskin files – simply download these to your hard drive, double-click the file, and follow the prompts to install the skin and any widgets it comes with – use the "Load included skins" box if present if you wish to display all the widgets on screen after installation.

Once installed, all available skins are accessible under the "Skins" tab under "Manage Rainmeter." You can load widgets from multiple skins at once, although their different styles may clash – if this is the case, see whether the new skin offers the equivalent widgets to replace those from another skin.

Some skins, such as Monterey, offer a global Settings.ini file within the main folder – select this and click "Load" to bring up a dialog enabling you to further customise the skin or access its widgets without having to use the "Manage Rainmeter" dialog.

Transform your Windows desktop

While Rainmeter gives your desktop a new purpose, it still relies on existing elements, such as your Start menu and Taskbar. If you're looking to reinvent the way you interact with the desktop, take a look at Cairo instead (**https://cairoshell.com**), which is both free and open-source.

Once downloaded, just run through the installer—note, if you run Cairo in place of Windows Explorer (rather than overlay it), you lose access to UWP/Windows Store apps and features, which is why this option is disabled by default. Once finished, leave "Start Cairo Desktop Environment" checked and click "Finish". The Windows Taskbar slides out of sight, then Cairo's desktop pop-ups, and you're taken through a welcome wizard.

Get organiSed

After the wizard, Cairo scans your computer for installed programs (including Windows Store apps if you've not replaced Windows Explorer). Drag apps from the right-hand pane to the left to add them to the "Programs" menu, or drag them right to remove them. Once done, click "Continue." Next, you're prompted to organise your programs into categories –

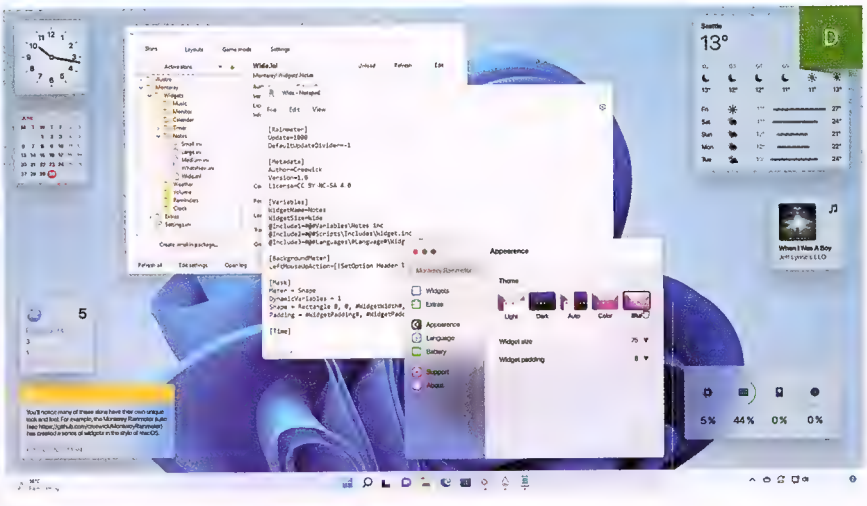
RAINMETER TIPS & TRICKS

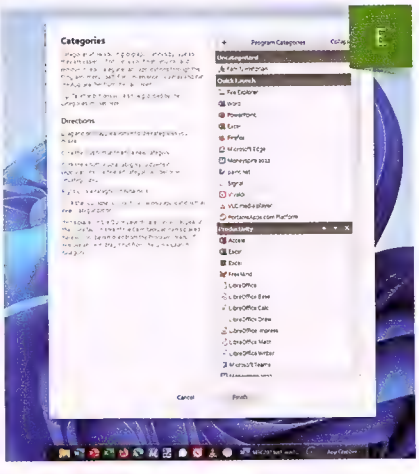
Once you've chosen which widgets to display and arranged them, switch to the "Layouts" tab on the "Manage Rainmeter" dialog. Give your layout a name and click "Save" – you can restore this from the same dialog if required.

If you find Rainmeter's monitoring tools interfere with your full-screen gaming, you can manually disable them when running D3D full-screen games via the "Game mode" menu on Rainmeter's Taskbar notification area icon. To configure what happens – and have Game mode run automatically – switch to the "Game mode" tab and check "Full-screen games." Additional programs can be added by checking "Additional process list" and typing the app's executable (program.exe) into the list. Use the "On start" button to determine whether all or selected skins are unloaded, and "On stop" to either restore the current layout or load a specific one.

Finally, to offload some of Rainmeter's processing, drawing, and memory demands to the GPU, check "Use hardware acceleration" under "Settings." You can also configure logging here if troubleshooting.

For more tips, see Rainmeter's dedicated Tips & Tricks documentation (**https://docs.rainmeter.net/tips**).





Cairo makes an initial attempt, but you're free to make changes as required [**Image E**]. Just drag and drop between categories or click "+" to create a new category. Use the down and up buttons to switch the order of categories. Click "Finish" when done.

You now find yourself at the desktop proper. Use the annotation on page 83 to familiarse yourself with its layout, then click the folder button on the navigation toolbar to select which folder you'd like to view on the new dynamic desktop. Its contents fill the screen – if there are too many folders and files to fit, use the scrollbars at the bottom to move around the folder, or click the Cairo menu button and choose "Cairo Settings > Desktop tab" to switch to small icons. While there, you can toggle the dynamic desktop feature on and off, plus set a new home folder for Cairo to default to.

Keep tweaking

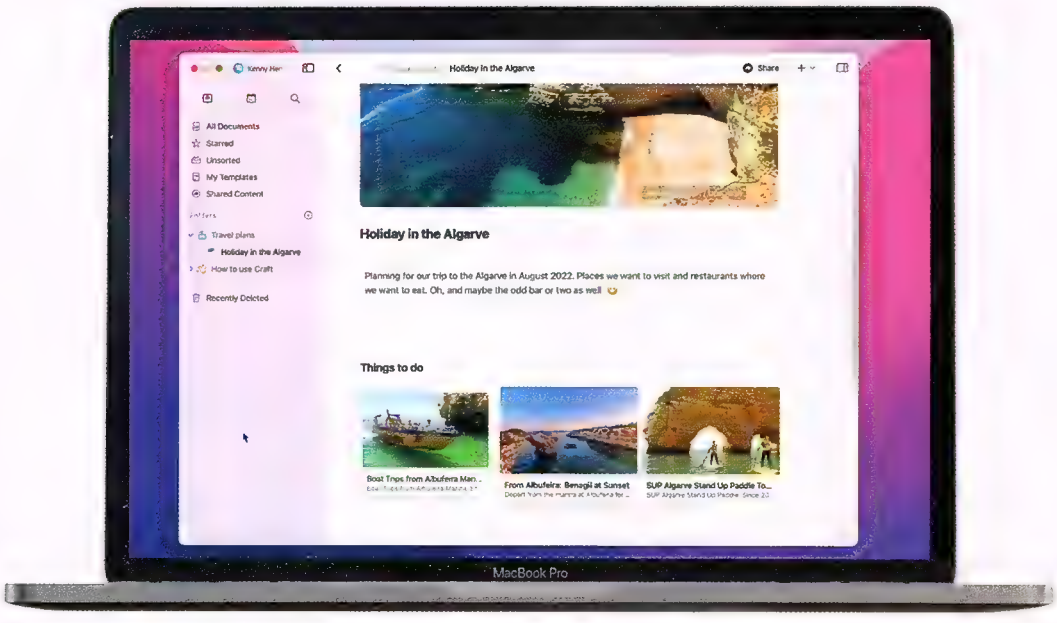
Cairo's Settings dialog enables you to further customize aspects of the program – for example, the Taskbar notification area hides most icons by default, but by switching to the "Menu Bar" tab, you can drag and drop those icons you'd like to be permanently visible. You'll also find most aspects of Cairo can be enabled or disabled as required, so if there are parts of it you don't like, just uncheck the relevant box and they vanish.

Should you wish to rearrange your programs and categories, open the Cairo menu and choose "App Grabber" to bring up the wizard you used earlier. The Cairo menu also provides you with power options, shortcuts to the Run command and Task Manager, plus – if you want to return to your regular desktop – the magic "Exit Cairo..." command. ■

MAC OS

Create amazing documents

Plan a holiday, research a renovation, or just make your notes look beautiful.


Holiday in the Algarve
Share
All Documents
Starred
Unsorted
My Templates
Shared Content
Travel plans
Holiday in the Algarve
How to use Craft
Recently Deleted
Holiday in the Algarve
Planning for our trip to the Algarve in August 2022. Places we want to visit and restaurants where we want to eat. Oh, and maybe the odd bar or two as well
Things to do
Boat Trips from Albufeira Mari...
From Albufeira: Benagil at Sunset
SUP Algarve Stand Up Paddle To...
MacBook Pro

IT WILL TAKE
30 minutes

YOU WILL LEARN
How to use Craft to create beautiful notes, emails and essays

YOU'LL NEED
Craft (Free, IAPs), macOS 10.15 or later

Craft combines creativity and organisation in one handy app. It's a cross between a document creation tool like Pages, where much of the emphasis is on physical documents that you print, and a note-taking tool like Notes, where the emphasis is on capturing thoughts and ideas.

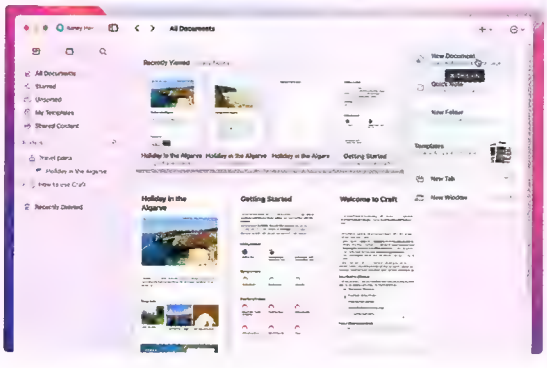
The idea is that you should be able to capture say meeting notes, or ideas for a project, or even draft an email but still present it in a way that looks beautiful. At its heart, Craft is a rich text editor with support for Markdown and code blocks. And, of course, you can add images, video, links, and attach files. Notes can be structured in any way you choose and you can nest notes within notes.

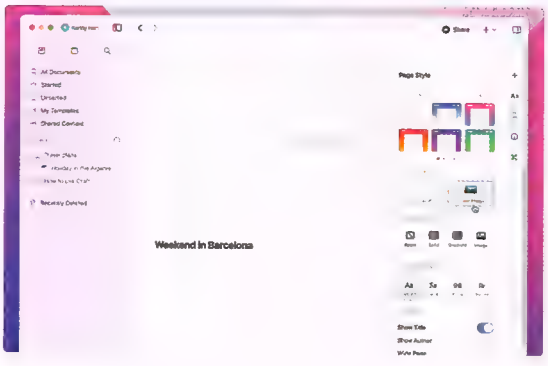
You can create Teams to collaborate on documents, share documents with what Craft calls Secret Links or export them via email, Markdown text, or PDF.

Craft is free to download, but if you want to make full use of its features, the Personal Pro version is $7.99/month.

HOW TO USE CRAFT TO PLAN A TRIP

GENIUS TIP!
You can set up teams on Craft's website and invite people to collaborate with you on documents you create or have already created.





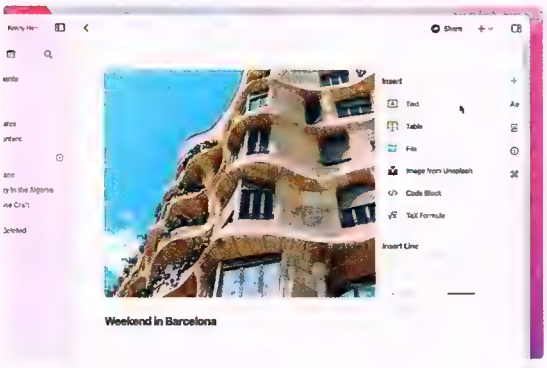
1 CREATE A DOCUMENT

To start with a template, click My Templates in the left pane, then View Craft Templates. We're going to start with a blank document. To do that, click All Documents, then '+' in the top right corner and New Document. Type a title.

2 ADD A COVER IMAGE

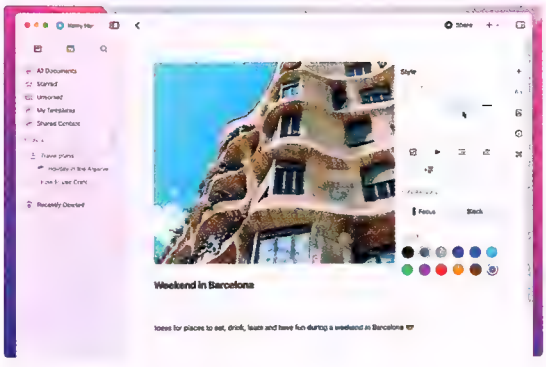
To choose a cover photo, click the middle icon on the right of the window and click Cover Image. Click the empty box. Choose Image from Unsplash or Insert File to your own photo. Click an image or click Open.

CONTINUED... USE CRAFT TO PLAN A TRIP



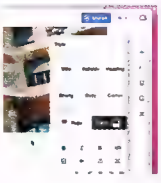
3 WRITE A DESCRIPTION

Click the '+' at the right of the main window and choose Text. Start typing your text in the box. To style the text, click in the text box and click 'Aa'. Choose from the options then click in the main window when you're done.



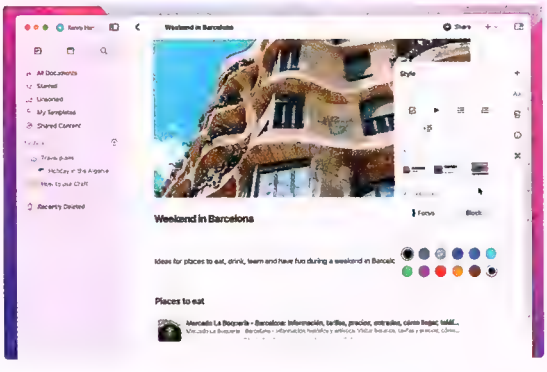
4 PUT IN A DIVIDER

We want to separate the description from our next block. Click '+' and, under Insert Line, choose the one you want and drag it from the sidebar onto the page. To restyle it, click on it, click 'Aa' and choose a style.



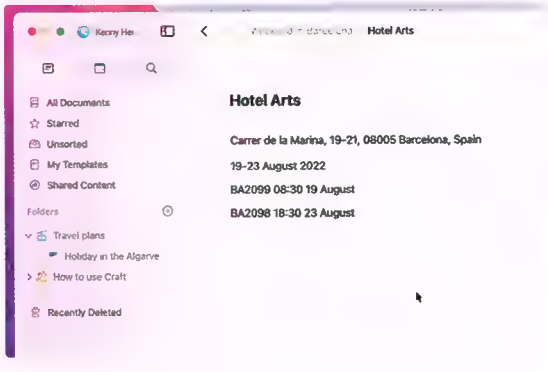
JARGON BUSTER

Blocks are simply paragraphs. When you hit return a block is created. Pages are blocks with content in them and Cards are Pages, but more stylish.



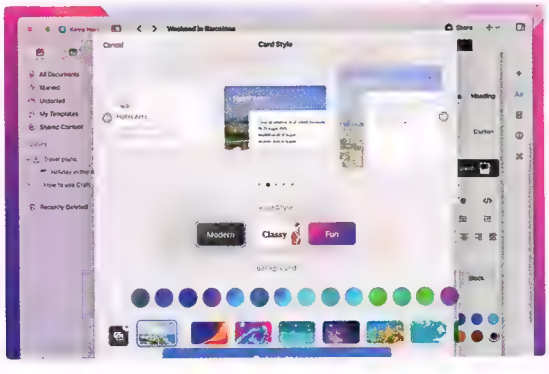
5 ADD A LINK

We want to collect ideas for activities in the form of links to websites. So, click '+' then Text and type a title for this section. Then add another text box and paste in a link. Click 'Aa' and choose one of the layout options.



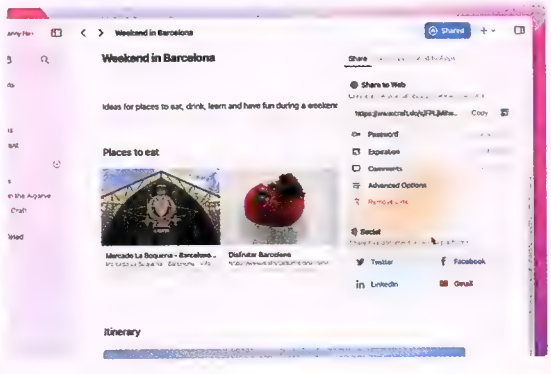
6 ADD ITINERARY

Put in another divider and a text box with the header 'Itinerary'. Click the arrow to the right of the header and type details of where you're staying, the dates, and any other details. Click the back arrow when you're done.



7 STYLE THE ITINERARY

Click in the itinerary box and click 'Aa'. Click Card. Choose a style for the card, using the ' key to scroll through them. Choose a font style and a background colour or image. When you're finished, click Apply Style.

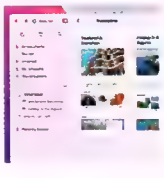


8 SHARE YOUR DOCUMENT

Click Share (top right), then Create to generate a link. Click Password if you want one, and Comments to manage those. Click Advanced Options to fine-tune other settings. When done, click Copy and share the link.

GENIUS TIP!

You can create folders, which live in the sidebar and then drag documents from the All Documents view on to a folder to store them there.



SECURITY

The seven sins of cryptocurrency

The dream has turned into a nightmare. Nathan Taylor looks at the many ways that crypto has failed us (and what you can do about it).

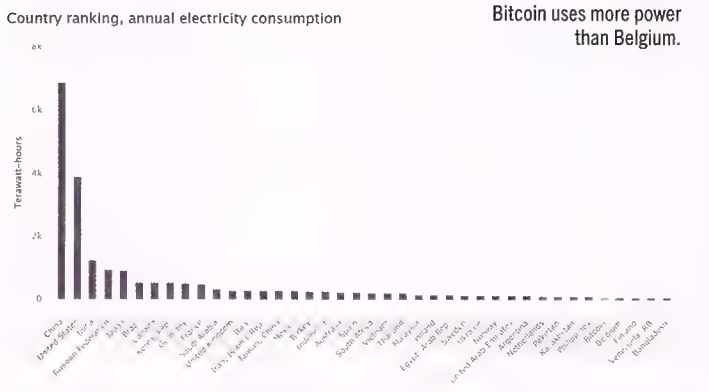
Bitcoin was launched in January 2009 with a bold vision. It was going to take control of finance away from the banks and institutions that caused the Global Financial Crisis and put it back in the hands of the people. No longer would greedy institutions control the flow of money, *technology* would.

"'Investment' schemes, rug pulls, romance scams, phishing scams, social media 'giveaway' scams, fake NFTs, tech-support scams and fake exchanges are just the tip of the iceberg."

As you're probably aware, that dream hasn't exactly panned out the way Satoshi Nakamoto and their collaborators dreamed. The cryptocurrency scene has been, more than anything, a case study in what a completely unregulated financial system looks like: a dumpster fire of small- and big-time scams, get-rich-quick schemes and wild market manipulation. It's no wonder most businesses still won't touch it.

All this is not to dump on the concept itself – we still believe there is virtue and potential in crpytocurrencies – it's just buried deep under a pile of risks that have to be sorted out before crpyto can be genuinely viable for the masses.

So here is our list of the seven big sins of cryptocurrency, and what (if anything) you can do to protect yourself against them right now.



Oh, Shuba Inu; everybody remembers the millionaires you made, but nobody remembers the equal number of paupers.

Scams

Oh, the scams. We barely know where to even begin with this. 'Investment' schemes, rug pulls, romance scams, phishing scams, social media 'giveaway' scams, fake NFTs, tech-support scams and fake exchanges are just the tip of the iceberg. There are so many, exacerbated by the fact that so many crypto investors know very little about how the platforms actually work. Crypto scams are a multi-billion dollar a year industry.

The fix

This one is hard to provide a universal answer for, but the general advice for all scams applies: do your research and don't be dumb with your money. Only deal with verifiable parties, and understand that once you hand control over your money to someone else, there's a better than even chance they're not going to give it back.

"Shitcoins", wash trading, and pump-and-dump

It's super-easy to create a new cryptocurrency – just copy and paste some code and you're away. Literally thousands of them are created every month, and 99.999999% of them are worthless. But there will those who try to convince you that they're not, that *this* coin is the one that will make you rich. FOMO ('fear of missing out') is a powerful force, and lots of people get sucked in daily.

Market manipulation of such currencies is common, since there's no regulation to stop it. Pump-and-dump is the name of the game: get a bunch of retail investors to FOMO into the coin and jack up the price, then dump, crashing the value and cashing out.

The fix

Know that you're gambling. Laying out money on 'early stage' cryptos is not investing. It's gambling, and your odds aren't great. You're betting that you can get out with a profit before the inevitable dump happens. The reality is, you probably can't, so never gamble more than you're willing to lose.

Investment Ponzis

There's a pretty fair argument that all of cryptocurrency investment is currently built on Ponzinomics, with the sector primarily sustained by new money flowing in. The inputs of the sector largely equal the outputs: for every $1k somebody makes, somebody else loses $1k.

But some investments are especially structured that way, with, again, no regulation to stop them.

The fix

If it's too good to be true, it almost certainly is. Giving people investment advice is not really APC's

© Cambridge Electricity Consumption Index, Shiba Inu

bag, but researching projects heavily is highly recommended. What value or service does it provide (and does it really provide it)? Is it only sustained by new money flowing in? Avoid those that are.

Hackers and criminals

Crypto hacks are so common now that they barely make the news. According to research firm Chainalysis, US$3.2 billion was lost to hacks in 2021, and 2022 is shaping up to be much worse. In the rush to get to market as quickly as possible, a lot of bad code has been pushed out by crypto and DeFi (decentralised finance) companies. There have been hacks big (of entire DeFi protocols and exchanges) and smaller personal hacks – where your phone or PC is compromised by malware and gives up your crypto keys.

The fix

When putting your money in new DeFi protocols, the advice in 2 and 3 above apply.

For your personal wallet, however, there are things you can do. Our strongest advice is to get yourself a hardware wallet from the likes of Trezor or Ledger. These can keep your funds in cold storage, disconnected from the internet and safe from hackers.

If you do keep your wallet on your PC or mobile, make sure you apply all the security tools they offer – two factor authentication, biometrics and more. Store your seed phrase somewhere safe (not in a file on your PC or phone) and never, ever, ever give your seed phrase to anybody else.

Unregulated and unaccountable exchanges

There's a lot to say about crypto exchanges, and very little of it good. They are banks without accountability or laws. They are they biggest players in a market that they themselves create, and are inveterate manipulators of that market, often betting against their own customers. They will run fractional reserves, selling crypto that they don't actually have; they will deny withdrawals when they feel like it; they will put their security failures on the customer ("we got hacked and lost your money: sucks for you!"); they will manipulate prices and front-run transactions, taking the best 'deals' for themselves; they will invest with their customer's money; they will make over-the-counter deals with whale investors, screwing over retail investors; they will happily facilitate criminality if it makes them a profit.

The fix

The best fix will come from regulators, when they finally come around to understanding cryptocurrencies and start implementing consumer protection and market obligation controls on exchanges.

In the meantime, you can try using decentralised exchanges like Uniswap, and making sure that you don't keep your money on the exchanges and instead transfer it to personal wallets (see Hackers and criminals section). Not your keys, not your coins is a real thing.

NFTs

NFTs are a microcosm of crypto as a whole – a good idea ruined by scammers and speculators. There are genuinely compelling real-world applications for NFTs – in fractional ownership, contract maintenance and trading; provenance tracking; in automated royalty payments; in identity.

Instead we get ape jpgs and artificial scarcity. We get rampant wash-trading to create an illusion of value. We get infinitely replicable digital assets being NFT'd to create unnecessary scarcity and predatory monetisation in video games and other platforms. NFTs are almost a parody of late-stage capitalism, and the whole scene would be funny if it weren't so depressing.

The fix

Once again, investment advice isn't really our thing. Just try to know what you're doing before leaping in, okay?

Environmental destruction

Blockchains were designed to use democratic validation of transactions. A new transaction is voted on, and if a majority say it is valid, then it gets processed. But there needs to be a way to prevent what are called Sybil attacks, where somebody creates a bunch of fake identities to stuff the ballot box.

Thus was born proof of work (PoW), the blockchain equivalent of solving a Captcha. To validate transactions, you first have to solve a mathematical problem – and the first party to do so gets a reward.

The system worked, but was pretty shortsighted, it turned out. As Bitcoin and Ethereum grew in value, it became a competitive game to solve it first. At its peak, Bitcoin alone was spitting up US$250,000 worth of rewards every ten minutes. Thus was born the mining arms race, which now sucks up huge amounts of global power production and has created a years-long shortage of the GPUs that are used to solve the proof of work. It's estimated that 0.5 percent of global power usage now goes to Bitcoin mining, which is an awful lot of empty work and a lot of CO_2 in the atmosphere.

The fix

Not all blockchains damage the environment this way. A great many newer blockchains employ a different consensus mechanism, most commonly proof of stake, where the authority to validate is granted by ownership of – or delegated authority from owners of – the native currency of the blockchain. Cardano, Polkadot, Algorand, Tezos and many others are proof of stake.

So you can choose to invest in and use these (relatively speaking) environmentally-friendly blockchains. It should be noted that Ethereum is moving from proof of work to proof of stake in the (hopefully) near future; it's unlikely that Bitcoin ever will, however. ■

Urgh

Hardware wallets like Trezor's can save you a lot of grief.

© Bored Ape Yacht Club, Trezor

PRODUCTIVITY

The tablet takeover

The latest generation of tablets may be ready to send your laptop packing, provided you don't ask too much of them. Bennett Ring downsizes his desktop.

Since their introduction over three decades ago, tablets have delivered the best touch-screen and stylus experience bar none. Whether you're an aspiring artist or a scribbling student, tablets have been built from the screen up to optimise non-keyboard interactions, while weighing little more than a hardcover book.

But when it comes to getting actual work done, tablets have struggled to match the mighty laptop. Poor performance and lackluster connectivity has limited them to the role of a secondary plaything in our modern arsenal of devices.

But things are changing. Apple's vaunted M1 laptop CPU has shaken things up in a big way, and now resides in the heart of its premium tablets. Meanwhile Samsung has crammed an octa-core 3GHz Snapdragon SM8450 beast into its top-shelf Galaxy Tab S8 Ultra. Throw in plenty of RAM, decent SSD storage (supplemented by the move to cloud), as well as USB 3.0, and these ultra-slim, ultra-light devices now look set to take on traditional laptop territory.

"When it comes to getting actual work done, tablets have struggled to match the mighty laptop."

APC put this theory to the test, using the best of these svelte offerings for a week, in place of our beloved MS Surface Pro, to see whether the new breed of tablets could be a bitter pill for the laptop market to swallow.

We used Samsung's Galaxy S8 Ultra in our testing, with mixed results.

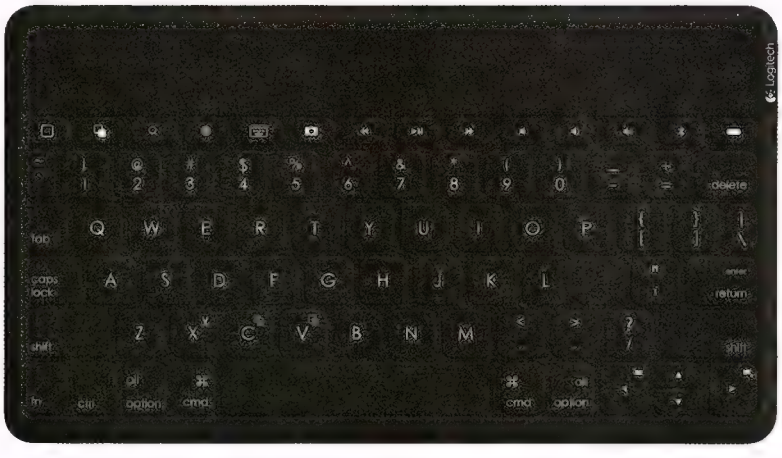
The hardware

The line between laptop and tablet is thinnest at the high end. We used Apple's 11-inch 3rd Gen iPad Pro to represent the might of the M1 chip ($1,349), while Samsung's larger Galaxy S8 Ultra ($1,799) showed off the best Android experience.

Logitech's beautifully crafted, Bluetooth-enabled MX Keys aluminium keyboard and MX Anywhere 3 mouse delivered a near perfect productivity experience, though Apple's age-old scroll wheel issues did rear their ugly head, requiring a bit of tweaking to get a decent response. BenQ's affordable 24-inch GW2485TC monitor was an able candidate to extend the displays of both tablets. Its slim lines and clear colours were put to good use thanks to both tablets finally supporting extended display mode, instead of the limited mirror mode of the past. You'll no longer need to buy an expensive dock to do so – we connected the screen to both tablets using the Alogic USB-C 3-in-1 HDMI mini hub, which also passed through power, for a mere $60.

iOS 16

Apple seems well aware that the powerful M1 chip in the iPad Pro and Air has been held back by the relatively basic iOS operating system. Enter iOS 16, which emphasises the desktop experience. Due for release in October, we installed the newly released public beta, and were immediately impressed. Extended display support for monitors up to 6K resolution was perfect, but even



A combo of the Logitech MX Keys keyboard and MX Anywhere Mouse 3 proved up to the task.

© Samsung, Logitech

Our test setup in action, and not a bit of space needed for a bulky PC!

better was the ability to side-dock up to four applications per screen thanks to the new Stage Manager feature – managing window position and size was as good as any desktop we've used. We could stack apps, or shuffle between windows with nary a slowdown. However, the recent delay to October does seem justified thanks to a few obvious bugs – closing a single app would often close all of them, for example, and sometimes apps would display incorrectly. Another glaring issue is cross-window copying and pasting, a feature which doesn't always work unless the app falls under Apple's new "Desktop Class" moniker (coming soon to all of Apple's productivity suite). We found the new Files application vastly more powerful than anything we've used on a tablet before, finally allowing for extension renaming, as well as simple file finding and moving.

If you want to make use of the fancy new iOS 16 features, they're sadly limited to iPads with an M-series CPU (the iPad Pro and iPad Air for the time being). Apple claims this is due to the performance requirements of the OS, but cynics argue that it's a clever ploy to force users to upgrade.

Samsung DEX

Samsung's approach to capturing a full PC experience in a tablet is called DEX (a not so obvious shortening of Desktop EXperience). Enabled on the Galaxy Tab S8 Ultra whenever we plugged in Samsung's Book Cover Keyboard or a HDMI monitor, it too allows for full display extension rather than simple mirroring. It wasn't as seamless as iOS though, with window organisation still relatively basic compared to anyone accustomed to Windows or macOS, and well behind Stage Manager.

DEX isn't mandatory to replicate the desktop experience, as running in the simple, no-frills Android mode worked beautifully. The powerful Snapdragon processor effortlessly handled multiple apps at a time, with Chrome in one window, while the Android versions of Outlook and Excel ran in the background. It was easily as responsive as a similarly priced laptop while sticking to these tasks, and considering just how thin and light this 15-inch tablet is, we can see many users finding this perfect as a laptop replacement if that's all they need to do.

Unfortunately things weren't so great when hooked up to a second display. Switching to DEX mode to extend the display felt rough around the edges; window resizing and moving was very basic, but worst of all was the severe lag encountered at seemingly random times. Situations that worked perfectly in single screen mode would often crawl to a near standstill when using DEX's extended display mode.

The verdict

If there's one issue that both the Apple and Android tablet ecosystems have, it's that the range of professional software available doesn't come close to a traditional laptop. However, for the majority of your daily uses, be it word processing, web browsing, media consumption and email, premium tablets now offer performance and an experience on par with a mid-range laptop. The introduction of iOS's Stage Manager in particular is a game changer, rivalling even a powerful desktop experience. Android has some catching up to do as a result, especially when it comes to outputting to a second display. Power users will likely find their most demanding applications aren't available on tablets, but for the rest of us, 2022 could be the year that tablets finally toppled the laptop, especially for Apple lovers. ■

Detachable tablet keyboards really aren't intended for long-term use, so connecting a proper keyboard really is a must.

© Annette Johnson, Logitech

MOBILE

Has your phone been hacked?

Your mobile device can be infected with malware without you knowing. Robert Irvine reveals how to spot the telltale signs and explains what you should do next.

Most problems with our smartphones, such as the screen going blank or an app failing to open, are nothing to worry about and can be fixed with a quick recharge or restart. But sometimes there are more sinister reasons for our devices misbehaving, especially because hackers are finding ever more devious ways to spread mobile malware. Particularly worrying are infections that run in the background, which can steal your money, data and identity before you even realise your phone has been compromised. Here, we reveal six giveaway signs that your Android phone or iPhone has been hacked, and explain the best ways to regain control.

> "If your phone's battery is running down more quickly than usual and it feels inexplicably hot, it could mean you've been hacked."

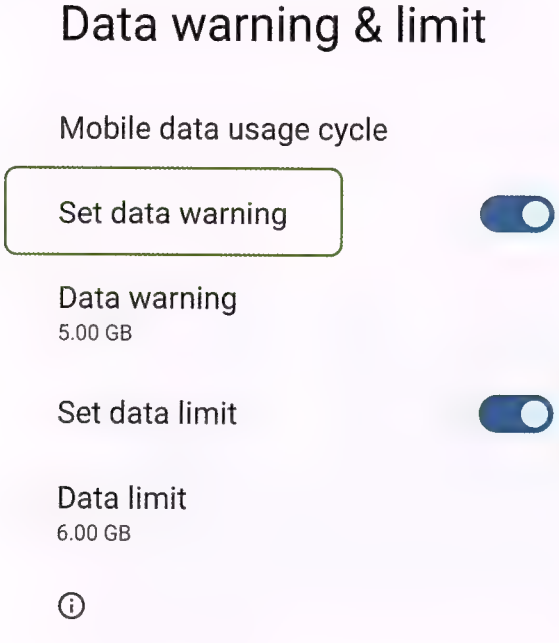
Excessive data usage

Even if your monthly phone plan includes unlimited internet access, an unusual spike in data usage can be a cause for concern. Malware could be connecting to servers in the background to download further malicious files, display adverts and upload content stored on your device.

To check your data usage on an Android phone, open Settings, select 'Network & Internet' then tap 'Mobile network'. Press 'App data usage' to see how much data your apps are using, in total and individually. If you spot a data hog you don't recognise, uninstall it or select it and disable 'Background data'.

Tap the cog below 'Mobile data usage' and switch on 'Set data warning' (see screenshot below left) to have your phone alert you about excessive data usage. Tap 'Internet' on the 'Network & Internet' screen and choose 'Non-carrier data usage' to see how much data apps have used when connected to Wi-Fi.

On an iPhone, open Settings, choose Mobile Data and ensure that no unknown apps are using excess data in the background. Either disable or remove any that are.



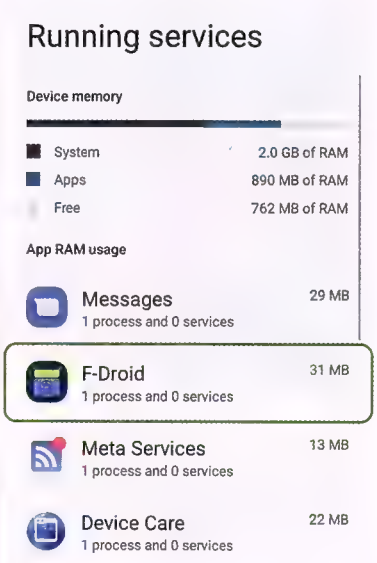
Check if suspicious apps are using data in the background and set up a warning.

Performance problems

If your phone's battery is running down more quickly than usual and it feels inexplicably hot, it could mean you've been hacked. Malicious activity in the background places a strain on system resources, which drains your battery and heats up your device. It may also overload your phone's memory, causing apps to freeze and crash.

Discover what's been sapping power on your Android phone by opening the Settings app then tapping Battery. Tap 'Battery usage' and check the list of apps for any suspicious entries.

It's also possible that a hidden process is causing performance problems. Find out by going to the System screen in Settings and choosing 'About phone'. Tap 'Build number' seven times to unlock developer options, then go back to System and choose 'Developer options' followed by Processes or 'Running services'. Select an unknown background process that's using a lot of RAM (for example, F-Droid is using 31MB in the screenshot above) and tap Stop to terminate its services.


Running services
Device memory
System 2.0 GB of RAM
Apps 890 MB of RAM
Free 762 MB of RAM
App RAM usage
Messages 29 MB
1 process and 0 services
F-Droid 31 MB
1 process and 0 services
Meta Services 13 MB
1 process and 0 services
Device Care 22 MB
1 process and 0 services

Unknown background processes can hog RAM and drain your phone's battery.

On an iPhone, open Settings and select Battery to view your apps' battery usage over the last 24 hours and 10 days. Tap 'General' then Background App Refresh to check and control which apps can update in the background.

Hijacked camera and microphone

The camera and built-in microphone on your phone can be hijacked by hackers to spy on you. Usefully, Android 12 and iOS (14 and later) tell you when your camera and microphone are being used by apps by displaying green and orange dots in the top-right corner of your screen. If you see either or both of these dots when not using an app that requires camera or mic access, hidden malware could be watching and listening to you.

Expose the intruder by checking your phone's 'privacy dashboard'. In Android 12, go to Settings, Privacy then select 'Privacy dashboard'. Tap the Camera and Microphone options (see screenshot above) to view apps that have accessed those tools in the past 24 hours, then tap 'Manage permission' to revoke

access for anything suspicious.

In older versions of Android, you can get the camera and microphone indicators on your screen by installing Access Dots (**tinyurl.com/APC511DOT**) and use the third-party app Privacy Dashboard (**tinyurl.com/APC511PRI**).

On an iPhone, open Settings and choose Privacy, then App Privacy Report to see which apps have accessed your camera and mic in the past seven days. Go back to the Privacy screen to adjust permissions for these features.

Unknown calls and messages

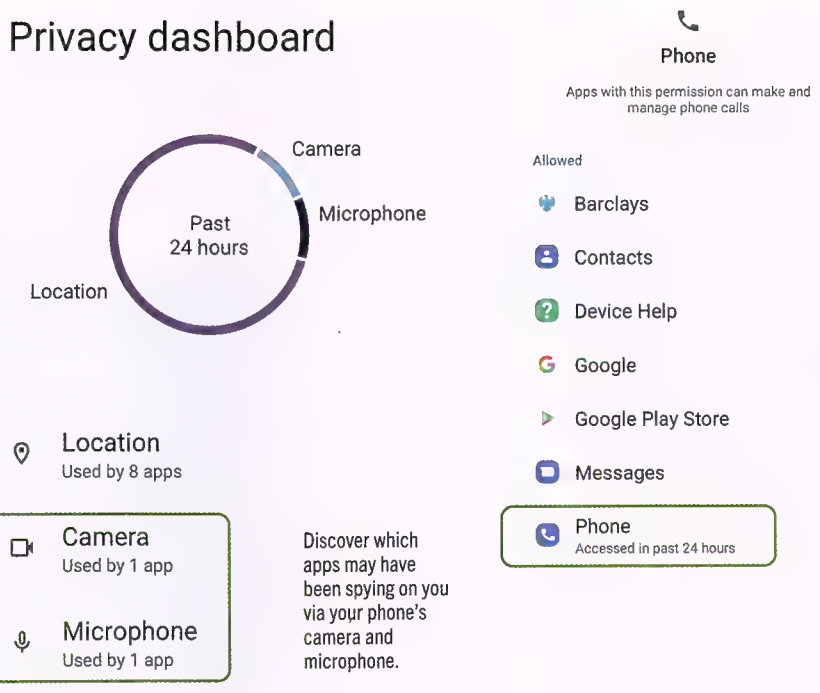
If the call history in your Phone app includes numbers you don't recognise, it's possible your phone is infected with dialer malware. This calls premium-rate numbers without your knowledge so that hackers earn money from your inflated phone bill.

Malware may also hijack your Messages app to subscribe you to expensive SMS services set up by hackers – such as the SMSFactory Trojan identified by Avast in June (**blog.avast.com/smsfactory-android-trojan**). Check your messages regularly for suspicious outgoing and incoming texts, and never open links in them, reply or ring any numbers listed in your call log.

You can stop these apps making calls and sending texts on your Android phone by going to Settings, then Privacy and tapping 'Permission manager'. Select 'Phone' (see screenshot above) to revoke permissions for suspect apps, then do the same for Contacts, 'Call logs' and SMS. Sometimes, as with SMSFactory, the malware will have no name or app icon, so look carefully for blank entries.

On an iPhone, go to Settings then Privacy to review and revoke permissions for your call and messaging features.

You should also contact your mobile provider and ask them to block premium- rate calls and texts from your SIM card.



Discover which apps may have been spying on you via your phone's camera and microphone.

Make sure unauthorised apps aren't making calls without your knowledge.

Constant pop-ups and strange icons

Pop-up ads in free mobile apps are a nuisance, but seeing them elsewhere on your phone suggests it may be infected with adware. Similarly, if your browser keeps redirecting you to strange websites, mysterious icons have been added to your home screen and ads appear in your notification tray, mobile adware could be to blame. These ads are usually more annoying than dangerous, but they may direct you to phishing sites or download threats when tapped.

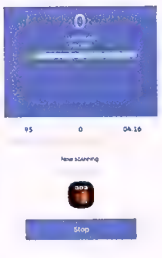
Identifying and uninstalling the app responsible for the ads will usually remove them but, if not, scan your phone with Malwarebytes Mobile Security (**tinyurl.com/APC511MAL**), which detects and deletes most adware (see screenshot below). As a last resort, you can factory-reset your device, but this will mean wiping all your data and you'll need to ensure you don't re-download the adware app automatically.

Unusual account activity

One of the most serious types of phone hack is known variously as SIM swapping, simjacking and port-out fraud, and involves criminals transferring your number to a new SIM card. This results in your network connection being cut off and the hacker gaining access to your messages, calls and personal data.

Signs you may have fallen victim to this scam include unexpected password-reset emails, security messages about new devices being linked to your account and a sudden loss of mobile signal. If you're worried about SIM-swapping, use an authenticator app such as Microsoft Authenticator (**tinyurl.com/APC511AUTH**) to sign into your accounts, rather than text-based verification codes that can be intercepted by hackers. ■

Scan your phone with Malwarebytes to detect and remove adware.



DO YOU NEED ANTIVIRUS ON YOUR PHONE?

Apple's strict App Store policies and the tight security of iOS mean you don't need an antivirus app on your iPhone. On Android phones, however, Google's Play Protect system, which is supposed to check apps you install for threats, isn't completely reliable, and dangerous apps are often discovered in the Play Store. Sideloading apps from alternative stores is even riskier, and if your phone doesn't receive regular security updates from Google via the manufacturer it could be vulnerable to hackers.

That said, if you only install apps from reputable developers (including those we recommend), never open links in unsolicited messages and don't connect to unsecured Wi-Fi, antivirus isn't essential for Android. If you want peace of mind, buy it from a trusted security company such as Avast, Bitdefender or Norton – most free antivirus apps are useless and full of trackers.

LINUX

Multi-boot USB drives

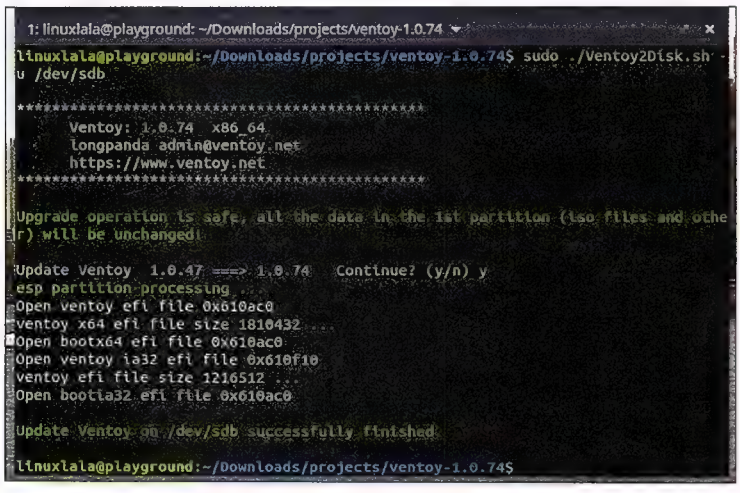
Shashank Sharma can't parallel park, but he knows how to just copy and paste live distributions into a USB drive to boot 'em up.

QUICK TIP!
In addition to storing ISO files, the partition on the USB drive can also be used as regular storage. However, to maintain sanity within the USB drive, we recommend you create a directory such as 'distros', or 'ISOs' to store your ISO and IMG files.

As far as we're concerned, the birth of live installable distributions remains the greatest watershed moment for the Linux ecosystem. You could quickly burn distributions on to a CD or DVD and boot into a functional Linux environment, without having to suffer through an installation and all that it entails. The only downside to this approach was the single-use nature of the CD/DVDs. But even this problem was overcome with USB drives, which you could wipe them clean and put in a new distribution at your pleasure.

With Ventoy, you can easily create multi-boot USB drives in almost no time at all. You can also deploy Ventoy on to a SD card, or even SSD, NVMe drives. You can also configure persistent mode on your Ventoy device, meaning that any changes you make to a Live session of a distribution will be available on subsequent reboots. For users looking to run an unattended installation, Ventoy supports this feature on distros such as Debian, Fedora, RHEL and Ubuntu Server.

The tool also has support for ISO files larger than 4GB in size, a customisable theme and menu, non-destructive upgrades and more. In addition to hundreds of Linux distributions, Ventoy has also been tested to work with a host of Unix operating systems. You'll find a list of these on the project's GitHub page (**https://github.com/ventoy/Ventoy**).


1: linuxlala@playground: ~/Downloads/projects/ventoy-1.0.74
linuxlala@playground:~/Downloads/projects/ventoy-1.0.74$ sudo ./Ventoy2Disk.sh -u /dev/sdb
Ventoy: 1.0.74 x86_64
longpanda admin@ventoy.net
https://www.ventoy.net
Upgrade operation is safe, all the data in the 1st partition (iso files and other) will be unchanged!
Update Ventoy 1.0.47 ===> 1.0.74 Continue? (y/n) y
esp partition processing ...
Open ventoy efi file 0x610ac0
ventoy x64 efi file size 1810432 ...
Open bootx64 efi file 0x610ac0
Open ventoy ia32 efi file 0x610f10
ventoy efi file size 1216512 ...
Open bootia32 efi file 0x610ac0
Update Ventoy on /dev/sdb successfully finished
linuxlala@playground:~/Downloads/projects/ventoy-1.0.74$

You can safely upgrade Ventoy to a newer version with the -u command option, which preserves all data such as image and json files.

Released under the GPLv3 license, Ventoy isn't available in the software repositories of most popular desktop distributions, but that's quite alright as the tool doesn't require any installation. With the exception of VentoyGUI, all other utilities are shell scripts, which don't require installation.

Apart from a CLI and desktop utility, Ventoy also offers a desktop GUI application as well as a browser-based GUI if you're so inclined. To begin, download the latest tarball and extract the files:

```
$ cd Downloads/projects
$ tar xvf ventoy-1.0.74-linux.tar.gz
$ cd ventoy-1.0.74/
$ ls
boot                README
VentoyGUI.aarch64   VentoyVlnk.sh
CreatePersistentImg.sh  tool
VentoyGUI.i386      VentoyWeb.sh
ExtendPersistentImg.sh  ventoy
VentoyGUI.mips64el  WebUI
log.txt             Ventoy2Disk.ini
VentoyGUI.x86_64
plugin              Ventoy2Disk.sh
```

PERSISTENT USB

Ventoy currently supports persistent storage on only a handful of distributions. To begin, run the **sudo ./CreatePersistentImg.sh -s 512** command. This is yet another shell script included in the Ventoy tarball.

Here, the -s command option is used to define the size of the persistent storage in MB. This command creates a persistence.dat file in your current directory. Copy this file on to the mounted Ventoy partition on your USB drive. In our case, we copied this file onto the /media/linuxlala/Ventoy1 partition.

You still need to inform Ventoy that you wish to use this persistance.dat file as storage for distributions. This is done by way of a json file. Open your favourite text editor and add the following lines:

```
{
  "persistence":
  [
    {
      "image": "/distros/ubuntu-21.10-desktop-amd64.iso",
      "backend":
        [
          "/persistence.dat"
        ]
    }
  ]
}
```

Take careful note of the square ([]) and curly brackets ({}). Save the file as ventoy.json and place it in the mounted ventoy partition of your USB drive. The **image** line of the file refers to the distribution for which you wish to enable persistent storage. The **backend** line is used to point to the file that you wish to use.

You can use the same persistence.dat file for different distributions if you prefer. But add separate **image** and **backend** lines in their own curly braces.

Ventoy now enables you to choose whether you wish to boot the specified distro with persistent mode.

VentoyPlugson.sh

The VentoyGUI tool is the native graphical utility, and you'll find versions for different architectures in the tarball. The VentoyWeb.sh utility provides the same functionality, but runs entirely in a web browser. For this tutorial, we'll work with the **Ventoy2Disk.sh** script to turn our vanilla USB drive into a multi-boot behemoth. You only have to invoke the relevant shell script from the terminal to work with Ventoy.

Deploy Ventoy

After extracting the tarball, plug a USB drive into the system. You can run the **fdisk -l** command to identify the USB device you've just plugged in:

```
$ fdisk -l
Disk /dev/sdb: 7.23 GiB, 7759462400 bytes, 15155200 sectors
Disk model:
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disklabel type: NTFS
Disk identifier: 0x7efb5116
```

We've clipped the output of the **fdisk -l** command due to space restraints, because the command outputs relevant details for all identified disks as well as each of their partitions. As you can see, our USB drive is identified as **/dev/sdb**. We'll be installing *Ventoy* on to this drive using the **Ventoy2Disk.sh** script extracted from the tarball. The process will destroy all data on the drive, so make sure to check and double-check the device name.

Once you've identified the disk which you wish to use with Ventoy, navigate into the directory where you extracted the **Ventoy2Disk.sh** file. We can now install Ventoy on to the USB drive:

```
$ cd ~/Downloads/projects/ventoy-1.0.47/
$ sudo sh Ventoy2Disk.sh -I /dev/sdb
[sudo] password for linuxlala:
<output snipped for space constraints.>
Install Ventoy to /dev/sdb successfully finished.
```

When installing Ventoy to a USB drive, you can use the **-I** command option to force installation. The **-i** command option will result in failure if the device already has a version of Ventoy installed. Alternatively, you can run the **Ventoy2Disk.sh -u /dev/path** command to upgrade Ventoy. The **Ventoy2Disk.sh** scripts creates two partitions in the specified device. You can run the **fdisk -l** command again to confirm. We'll only work with the larger of the two partitions.

```
linuxlala@playground:~/Downloads/projects/ventoy-1.0.74$ sudo sh Ventoy2Disk.sh
--help

**********************************************
      Ventoy: 1.0.74  x86_64
      longpanda admin@ventoy.net
      https://www.ventoy.net
**********************************************

Usage:  Ventoy2Disk.sh CMD [ OPTION ] /dev/sdX
  CMD:
    -i  install Ventoy to sdX (fails if disk already installed with Ventoy)
    -I  force install Ventoy to sdX (no matter if installed or not)
    -u  update Ventoy in sdX
    -l  list Ventoy information in sdX

  OPTION: (optional)
    -r SIZE_MB  preserve some space at the bottom of the disk (only for install)
    -s/-S       enable/disable secure boot support (default is disabled)
    -g          use GPT partition style, default is MBR (only for install)
    -L          Label of the 1st exfat partition (default is Ventoy)
    -n          try non-destructive installation (only for install)

linuxlala@playground:~/Downloads/projects/ventoy-1.0.74$
```

Run the sudo ./Ventoy2disk.sh --help command to access the help section. All the Ventoy scripts included in the tarball provide basic assistance.

To now create a multi-boot USB drive with Ventoy, you only have to copy the ISO files on to the newly created Ventoy partition. When you mount the USB drive, this larger partition is the only one that becomes mounted. Depending on your distribution of choice, the partition would be mounted under **/media/linuxlala/Ventoy1**.

You can copy as many ISO files as you like on to this partition, depending on the size. When you unmount the device and boot into it, you'll be greeted with a GRUB menu that offers the choice of all the different distributions that you put into the Ventoy partition on the USB drive.

Ventoy will scan the entire USB drive and automatically identify all ISO files, irrespective of their location, and present a GRUB menu for you to choose which distribution to boot into.

By default, all changes you make to a Live environment are destroyed as soon as you restart or shutdown the distro. Refer to the Persistent USB box (opposite page) if you wish to enable persistent storage for Live distros on Ventoy-powered USB devices.

Ventoy is highly configurable and you can play around with themes and menu items. The project provides **VentoyPlugson.sh** script to help you create a **ventoy.json** file which controls the behaviour and appearance of Ventoy.

Run the script with the **sudo ./VentoyPlugson.sh /dev/sdX** command, replacing the device name at the end to reflect the device in which you've installed Ventoy. You'll be provided a URL, such as **http://127.0.0.1:24681**. Point your browser to it, and then use the sidebar to navigate the different configurable parameters and create your custom **ventoy.json** file, which will automatically be stored in the mounted USB drive.

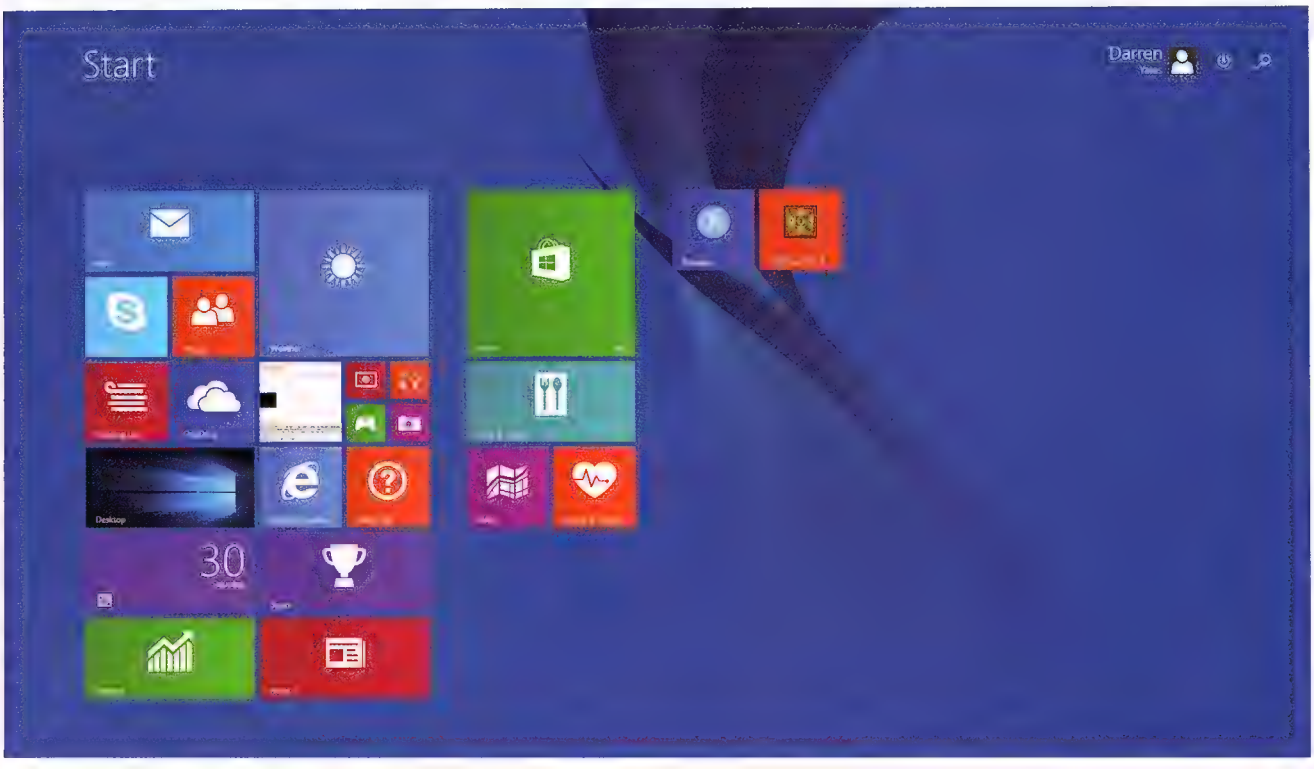
Head over to the project's website (**www.ventoy.net**) for a list of all the supported distributions as well as the ones that support persistent storage. You'll also find useful information on all the different Ventoy utilities such as VentoyGUI and VentoyPlugson. It's also possible to replace the default Ventoy boot menu with one that features custom images. The ability to work with different devices, and not just USB, makes Ventoy indispensable. Couple this with persistent storage, safe upgrade and the customisation options, and you have a tool that can help you effortlessly impress your peers. ■

"With Ventoy, you can easily create multi-boot USB drives in almost no time at all. You can also deploy Ventoy on to a SD card, or even SSD, NVMe drives."

WINDOWS

Good-bye, Windows 8...

After more than a decade, Microsoft is calling time on its once-controversial operating system. But what do you do when an OS goes end-of-life? Darren Yates looks at the options come January 2023.



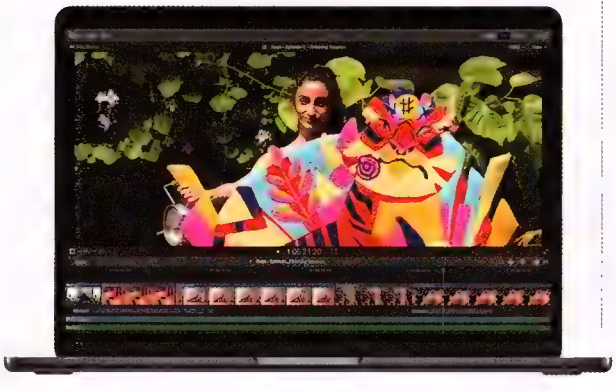
Windows 8 security updates end on 10 January 2023.

After the success of Windows 7, Microsoft was always at long-odds to achieve the same popularity with its follow-up. Windows 8 was superseded inside three years by the release of Windows 10, nevertheless, this last single-digit release is reportedly still plugging away on as many as four percent of systems worldwide seven years later. Now, Microsoft is pulling down the shutters on its old OS, with security updates to cease on 10 January 2023. We look at your options, the risks and the costs.

Not again...?

The thought of upgrading will either provide the excuse to buy yourself some new kit, or fill you with dread at having to change from years of well-worn habits. Not everyone enjoys the task of upgrading and although its Windows 8 today, Windows 10 owners will come up against the same issue in 2025 when Microsoft next turns off the security updates tap. So, regardless of which OS you're using right now, the question of 'what to do next' is one we all need to deal with. Here are the options now.

Apple's new M2 hardware may make macOS an appealing option.



Do nothing

You could simply ignore the warning bells and just keep using Windows 8/8.1 as it is. For sure, your OS will boot up as usual on 11 January 2023, but you may soon find other problems. First is security. With no new fixes, the OS will become increasingly vulnerable to attack. It may be that researchers no longer bother looking at Windows 8, so new flaws may remain undiscovered, except possibly by those up to no good (then again, the 'black hats' may lose interest in Windows 8, since so few people will continue to use it). Clearly, if you wish to keep using Windows 8, you have to be aware of the risks – or at the very least keep this computer off the internet.

Software developers rely on application development environments/systems to create new apps and as those systems start losing Windows 8 support, your apps will also begin dropping Windows 8/8.1 support pretty quickly. Finally, if you do online banking on this machine, it's time to stop.

Upgrade to Windows 10

Still, Windows 11 hasn't exactly won universal praise (Microsoft's yes-no cycle of OS releases continues, it seems) and if you're quick, you might still grab a copy of Windows 10 Home or Professional. But this raises the conundrum, which is dropping a new OS onto an older system.

The first problem here will usually be a lack of RAM, simply because the amount of RAM supplied with new systems continues to rise over time. Windows 10 doesn't really get out of bed for anything less than 8GB and if your old Windows 8 system has only 4GB, Windows 10 will likely struggle to do more than crawl around with a hangover.

© Darren Yates, Apple

Then there's the increased load each new OS brings – add this to an older CPU with a lack of RAM and you can imagine the result. If the budget's tight, upgrading to 8GB and swapping out an HDD for an SSD may get you a fair result from a Windows 10 upgrade – but only if on a quad-core CPU.

Upgrade to Windows 11

If you read Jon Honeyball's report in the August issue of *APC*, you'll know Windows 11 is equal parts uninspiring and infuriating. Nonetheless, there are ways to knock Microsoft's latest OS into some sort of shape. But as for hardware, Windows 11's minimum requirements are more onerous, even if they look benign – 1GHz dual-core CPU and 4GB of RAM sound simple, but our opinion is Microsoft under-quotes and you need double that for decent performance. The greater issue is the need for Trusted Platform Module (TPM) version 2.0 support – without this, Windows 11 won't run without mods. That's why in this case, Windows 11 is a bit like a $15,000 dishwasher that comes with a free kitchen – you really have no option but a full hardware upgrade as well to ensure it's OS-ready.

Jump to Linux

This is the perennial question, isn't it – do I stay with Windows or pull the trigger and jump to Linux? Personally, I've tried many times to jump, but I've always found myself coming back to Windows as my daily driver because of an app that only exists on Windows I can't do without (if anyone has circuit emulator LTSpice running on Linux, let me know!).

So, bottom line, it really depends on your work flow – which apps can you not live without and are there Linux-based versions that do the job. If not, you're probably best to stick in the Windows lane. However, if gaming is more your thing, Steam makes Linux well worth a look before forking out for Windows 11 – just be aware that most parts suppliers will not sell you the cheaper OEM version of Windows unless you buy hardware with it, so if you buy your new hardware first and try Linux, you may be forced to buy the pricier retail version of Windows if you come back later.

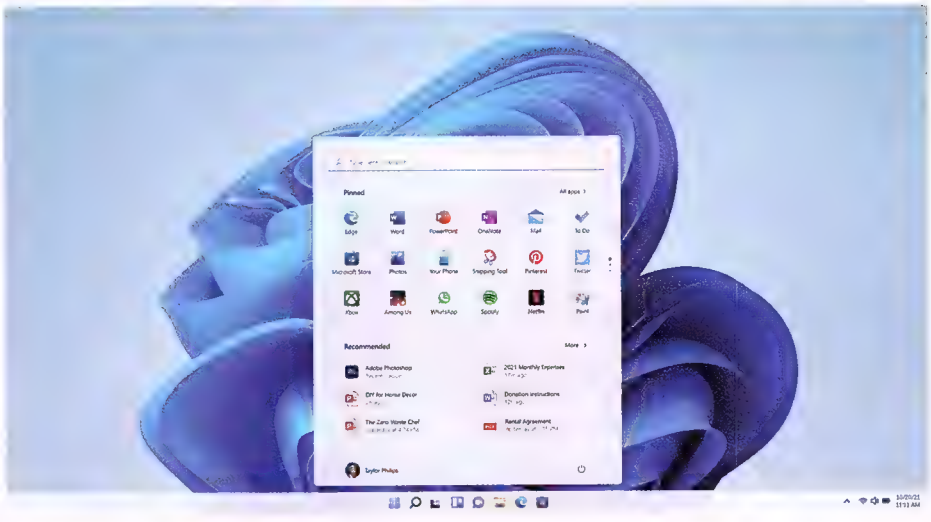
Go macOS

When Windows Vista arrived in 2006, the whole 'user account control' (UAC) debacle was parodied in a classic 'I'm a Mac and I'm a PC' ad (search YouTube). Apple won't say but I'd love to know how much Vista did for macOS sales at the time. The distinct lack of love for Windows 11 currently might be another 'Windows Vista' moment for macOS, particularly with Apple now running its own CPU architecture and showing excellent speed.

If you're thinking about jumping to Apple, the same questions apply as those for jumping to Linux – can you get the apps you need running on macOS. But it's also a bit more of an existential jump, too. The thought of buying any complete ready-to-run computer makes me wince (and yes, I take forever to buy a laptop). Having to jump into a new OS as well I've found a bridge too far. That I also can't fix it, replace components or upgrade it the way I wish also doesn't exactly fill me with happiness. Being pragmatic about it, if you're thinking gaming, I'd look at Linux before macOS, but for creative/video work, I'd go macOS before Linux.

Good-bye, Windows 8

Saying good-bye to a PC simply because the OS goes end-of-life I find one of the more infuriating things in tech. Windows 8/8.1 has few friends today, but I find it's a bit like saying good-bye to a beat-up old ute – you know you've got to get rid of it, it rides hard and its clapped out, but it's seen you through plenty and you know you'll probably miss it when you turn off the ignition for the last time. Thanks for the ride, Windows 8. ■



Top: If you hurry, you can still buy Windows 10 installer media. **Above:** Windows 11 has tougher hardware requirements, including TPM2.0.

Linux is the open-source option well worth trying.

© Microsoft, Darren Yates

RASPBERRY Pi PICO

Build a "rubber ducky" device from a Pi Pico

Discover why the classic fake keyboard hacking device is ideal for the Raspberry Pi Pico and Matthew Holder's very particular set of skills...

GENIUS TIP!
A more feature packed rubber ducky project can be found at **https://github.com/dbisu/pico-ducky**

Let's have some fun with the Raspberry Pi Pico. We're going to try a couple of basic projects and we'll discuss how to install different types of firmware on the board, write a program to flash an LED and then discuss the configuration required to set up a board as a so-called rubber ducky device. We'll configure our rubber ducky to enter simple keypresses.

During this tutorial, we will discuss how to install different types of firmware on the board. Examples of firmware are micropython, CircuitPython, C/C++ and the Arduino language and programming tools. Following firmware installation, we'll write a program to flash an LED and then discuss the configuration required to set up our board as a rubber-ducky, style of device. In this example, we will configure the rubber-ducky to enter simple keypresses. With a little more imagination, it would also be possible to configure a device to operate in a similar manner to the streamdeck shortcut devices.

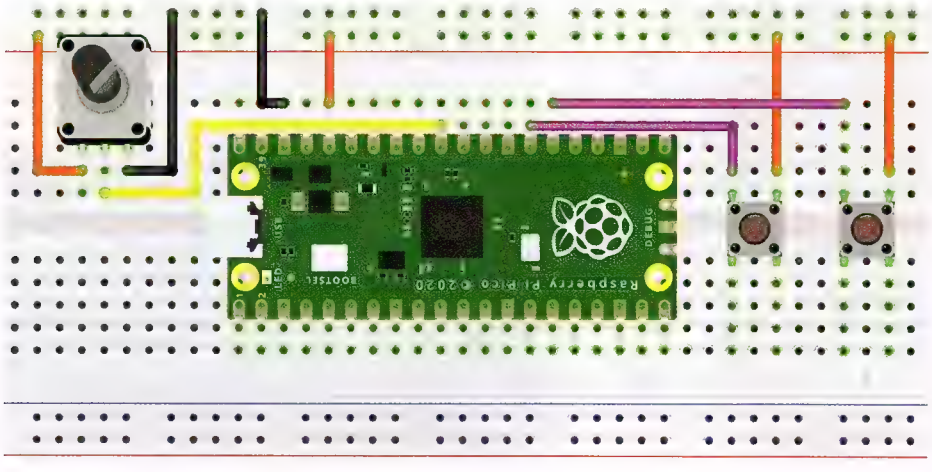
Before beginning with the projects, we'll install CircuitPython on the board and install the mu editor on the device we'll be programming from. Open a terminal on the device used to create the program and enter **sudo apt install mu-editor** on an Ubuntu-based distribution and **sudo dnf install mu** for Fedora.

To install CircuitPython on the board head to **https://circuitpython.org/board/raspberry_pi_pico** and download the latest version. Hold down the BootSel button on the Pi Pico and connect to USB. The uf2 file that you recently downloaded can then be copied to the drive that's mounted. When completed, the device will restart and a new drive will be shown, which is where the **code.py** file can be copied to for the device to run.

To be able to write our programs, open mu. On first load this will ask which mode it should operate in. Select CircuitPython and if all is well the text editor will finish opening with a text editor screen in the middle. This is where the Python code will be entered. Also note the button to open a terminal to the device, which is where Python can be entered manually and where programs can be interacted with. The Serial button on the toolbar provides access to the board's REPL, where the board and program can be interacted with directly.

> "With a little more imagination, it would also be possible to configure a device to operate in a similar manner to the streamdeck shortcut devices."

Here's the circuit diagram for both projects. See the left-hand side for the LED project and right hand side for the rubber ducky.



Flashing an LED

This is the Hello World of hardware programming. We'll add a small twist to the usual program and use a potentiometer to control the speed of which the LED flashes. We'll also discuss the usage of Pulse Width Modulation (PWM) to control the brightness of the LED.

To create this functionality requires a small amount of code. First, we must import the libraries we wish to use and define the output pin for LED control, with a type of PWM and an input pin on one of the analogue compatible pins for the potentiometer to connect to. Next we define a while loop, which runs forever and sets the **duty_cycle** of the LED (the ratio of On to Off, which controls the brightness) to the value as read from the analogue input. The **duty_cycle** value needs to be in the range of 0-65,535. This is also the value read in from the analogue port. If we wanted to see the voltage of the pin, rather than a number, we divide 65,535 by the value read from the input and then multiply by 3.3V. Turning the potentiometer will now change the LED's brightness.

Enter the code below into the text editor and save to the RPi Pico's USB drive as **code.py**. The program will then execute with the functionality described above.

```
#Use a potentiometer to control the brightness of the built-in LED
    import board
    import analogio
    import pwmio
    led = pwmio.PWMOut(board.LED, frequency=1000)
    potentiometer = analogio.AnalogIn(board.GP26)
```

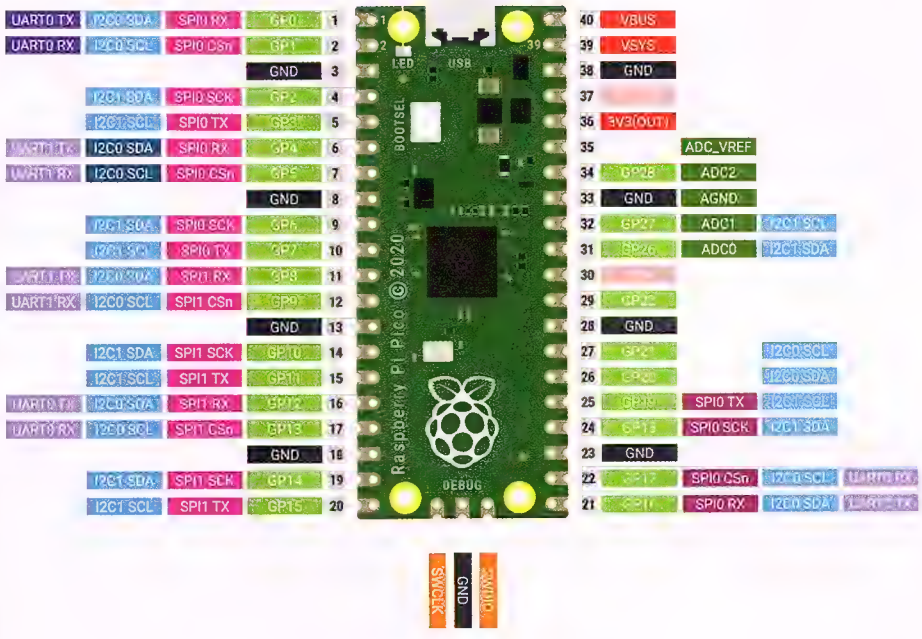
```
while True:
    led.duty_cycle = potentiometer.value
```

Second, we'll use the potentiometer to control the rate that the LED flashes. Here, we define the pin to use for the LED and set the pin to be the type of output. Again, this uses the LED on the board. We define a variable to represent the analogue input, which is linked to GPIO pin 26. Finally, we define a while loop, which runs forever. To start, it reads in the analogue port and divide the value by 65,535. This gives a value between 0 and 1. Next, the LED is switched on and then the code is set to wait for the value calculated by reading the value of the input pin and dividing by 65,535. We then switch the LED off before waiting again. Turning the potentiometer changes the frequency of the LEDs flashes. As before, enter this code into the text editor, replacing what was there before and save as **code.py**.

```
#Use a potentiometer to control the frequency that the LED flashes
    import time
    import board
    import digitalio
    import analogio
    # Pulse an LED with frequency controlled by a potentiometer
    led = digitalio.DigitalInOut(board.LED)
    led.direction = digitalio.Direction.OUTPUT
    potentiometer = analogio.AnalogIn(board.GP26)
    while True:
        flashFreq = float(potentiometer.value) / 65535
        led.value = True
        time.sleep(flashFreq)
        led.value = False
        time.sleep(flashFreq)
```

One of the interesting design choices of the Pico board is the addition of two programmable I/O blocks. Each block can run four-state machines and can be used to offload some program functionality from the main CPU cores. Functionality can be written for the PIO slots using *MicroPython*. An example of this, which blinks an LED can be seen at **https://docs.micropython.org/en/latest/rp2/tutorial/pio.html**. This doesn't look like usual Python code and this is because the PIO instruction set consists of only nine commands.

We've merely scratched the surface of what this inexpensive, yet powerful microcontroller board can do. Enjoy experimenting! ■



The Raspberry Pi Pico pinout can be seen here: (**https://bit.ly/lxf292pico**). Credit: Raspberry Pi Foundation

CREATING A SIMPLE RUBBER DUCKY

A rubber ducky is a device that imitates a keyboard. In this example, we'll connect two switches to the Pico device and program one to imitate the Super-Key and the other to imitate the Print Screen key. First we add the USB Human Interface Device (HID) libraries to the Pico. Download the library files (**https://circuitpython.org/libraries**), extract the archive and copy the adafruit_hid folder to the lib folder on the Pico.

First we import the libraries for digital IO and USB HID functionality. Second, we define a variable to represent the keyboard we will emulate. Next, the buttons and LED are initialised as three of the GPIO pins. Now we start an infinite while loop and read the state of the buttons. If the pin associated with button 1 goes high (showing the button has been pressed) we send the Super-Key scan code. Similarly, the pin linked to button 2 is scanned and when this goes high, the scan code for the print screen key is pressed. Test this by pressing the buttons and noting what happens. See the right-hand side of the circuit diagram (left) to view the wiring diagram for this project.

```
    import usb_hid
    from adafruit_hid.keyboard import Keyboard
    from adafruit_hid.keycode import Keycode
    import time
    import digitalio
    import board
    kbd = Keyboard(usb_hid.devices)
    button1 = digitalio.DigitalInOut(board.GP20)
    button1.direction = digitalio.Direction.INPUT
    button1.pull = digitalio.Pull.DOWN
    button2 = digitalio.DigitalInOut(board.GP21)
    button2.direction = digitalio.Direction.
    INPUT
    button2.pull = digitalio.Pull.DOWN
    led = digitalio.DigitalInOut(board.LED)
    led.direction = digitalio.Direction.OUTPUT
    def flashLed():
        led.value = True
        time.sleep(0.1)
        led.value = False
    while True:
        if button1.value == True:
            kbd.press(Keycode.WINDOWS)
            kbd.release_all()
            print('Button1')
            flashLed()
        if button2.value == True:
            kbd.press(Keycode.PRINT_SCREEN)
            kbd.release_all()
            print('Button2')
            flashLed()
        time.sleep(0.20)
```

DOWNTIME

LEARNING ABOUT OLD MACHINES AND BRINGING THEM BACK TO LIFE VIRTUALLY

MACHINE OF THE MONTH

Commodore PET (1977)

John Knight takes a close look at one of the coolest computers of all time.

■ **CPU:** MOS Technology 6502 @ 1MHz, **RAM:** 4-32KB; 96KB, **Graphics:** Monochrome text, 40 × 25 or 80 x 25 columns, **Storage:** Cassette, 5.25-inch floppy, 8-inch floppy, and external hard drive, **OS:** Commodore BASIC 1.0, **Released:** June/December 1977, **Production:** 1977-1982, **Worldwide sales:** 5.7 million.

This month, we cover a historic pillar of personal computing. Alongside the Apple II and Tandy TRS-80, the Commodore PET is one of three major computers (aka The Holy Trinity) that are credited with starting the home computing revolution, and its architecture would later underpin Commodore's most popular machines.

As you might expect, the PET is full of quirks and can present some technical headaches to a modern user, so after taking you on a brief history tour that goes all the way back to the mid-1970s, allow us to guide you through emulating the Commodore PET.

Development and launch

The PET's story begins in 1976. In an attempt to match rival Texas Instruments, which was making its own processors, Commodore acquired chip manufacturer MOS Technology – maker of the now famous 6502 CPU. Commodore had a presence in the calculator market and wished to continue in this direction, but 6502 chief designer Chuck Peddle would certainly change all that.

At that time, the MOS 6502 had barely been used, and home computing was still a new concept. Frustrated by not seeing his processor used to its potential, Peddle convinced Commodore boss Jack Tramiel to focus on computers, which he perceived as the future of technology, instead of calculators.

The PET was first announced in January 1977, when it was demonstrated at Chicago's Consumer Electronics Show. First orders were taken in June, although deliveries didn't begin until December, giving the Apple II and Tandy TRS-80 a headstart.

The original PET model, the 2001, was a large all-in-one design with the keyboard, monitor, and tape drive all built into the same chunky 44lb steel chassis. Powering the machine was a standard 1MHz 6502 processor, with 4KB of static RAM.

For an operating system, the PET was the first mass-market machine to run Microsoft BASIC (branded as Commodore BASIC), which could do floating-point computations, out-classing Apple Integer BASIC.

Cassette was the only storage method available on launch; the tape drive was an off-the-shelf product with slight modifications, mounted inside the chassis. The original keyboard, meanwhile, was criticized for being far too small.

The PET has no graphics – everything is 40 columns text-based and restricted to the machine's PETSCII character set, which can't be modified. This is all viewed through a nine-inch black-and-white screen. It originally came with no sound, although owners eventually worked out a wiring hack via the user port to generate simple noises.

Above: Jack Tramiel chose the name PET to positively associate it with the Pet Rock craze, back-naming it the Personal Electronic Transactor.

Software

The PET's software range was largely business and science-oriented, with popular office software like the WordPro series, and advertisements for adrenaline-pumping applications such as Mortgage Analysis and Basic Statistics Package. Nevertheless, coders still found ways to have fun. The PET's character set is extensive and was put to great use by many games. Like the Sinclair ZX81, clever coders worked out exploits to grab slices of PETSCII characters one line at a time to create images close to bitmap graphics.

To pick some gaming highlights, *Millipede* (1982), *Space Invaders* (1980), and *Lode Runner* (1983) all provide classic gaming that makes good use of PETSCII characters. For something that pushes the machine harder, *Voyager 1* (1982) has the mechanics of a first-person dungeon-crawler, but with a futuristic spaceship setting. *Shootout* (1982) is a sophisticated 3D space shooter with impressive movement that looks like real graphics. For modern gaming options, check out *Pet Tetris* (2010) and *PETSCII Portal* (2021), but chief praise must be given to YouTuber David Murray (aka The 8-Bit Guy), who has developed the cult arcade/strategy/puzzle game, *Attack of the PETSCII Robots* (2021).

© Photograph by Rama, Wikimedia Commons, Cc-by-sa-2.0-fr

Legacy

The PET was an immediate hit and quickly established Commodore's new direction. The line was soon upgraded, starting with the keyboard – Commodore switched to the now-familiar external tape drive design to make room for a bigger keyboard.

The screen was enlarged to 12-inch, using a green-on-black display, plus a small speaker was added, so owners no longer had to hack wires into the user port.

Later models would receive RAM upgrades, with either 16KB or 32KB maximum. Technological advances eventually allowed up to 96KB, plus machines with 80-column text modes, though software was not usually compatible between 40 and 80-column machines.

Floppy drives were eventually released in 1979, including both 5.25-inch and 8-inch models, as well as external hard drives several years later, with 5MB and 7.5MB variants.

The PET series eventually morphed into the CBM line, designed for the business market in Europe. Sales of the PET began to decline in 1982, with around 219,000 sales worldwide – a solid figure for the time – when it was superseded by the VIC-20.

Emulation

The most popular emulator for the PET is VICE, which supports Windows, Linux, Mac, and many other platforms.

For Windows, head to **https://vice-emu.sourceforge.io** and download the latest build. After extracting the package, go into the new folder, open the bin folder, and manually open xpet.exe. You might want to make a desktop shortcut.

For Linux users, VICE is available in distribution repositories, but we don't recommend this as it will probably be missing core system files due to licensing restrictions. You can get these files from a source tarball, but it's much easier to install the Flatpak package instead, available at Flathub or possibly in your distro's app store. Flatpak should install entries in your system menu.

Loading software

Most software online is .d64 disk files or .prg program files. Regardless of format, VICE makes life simple by handling these files through its "Smart Attach" function, which auto-detects file types, automatically enters LOAD commands, and even activates Warp Mode while your program is loading.

To get started, go to "File > Smart attach." Choose your image from the file browser, then click "Autostart." VICE tries to load your files by entering standard LOAD commands. If you get stuck at the BASIC prompt with nothing happening, just enter:

```
RUN
```

However, this simply loads whatever program the PET finds first. Sometimes you need to specify the name of a program, such as when loading files from a compilation disk. Newer versions of VICE can be of assistance here, as when you select a disk image during the "Smart Attach" process, it lists any files within the image in the Image Contents panel on the right – even if they're still zipped.

Any usable programs have a number on the left, the program name in double-quotes in the centre, and a PRG designation on the right. For instance, the game *Joust* on PET Games Disk 11 was listed as: 21 "JOUST" PRG

On newer versions of VICE, you can simply select this line from the Image Contents panel, then click "Autostart" to load the game. With older versions, you need to take a harder route, entering manual commands. Start by writing down the program name shown in the Image Contents panel. Instead of clicking "Autostart," click "Attach", then manually enter the LOAD command. Sticking with Joust, the command looked like this, however, you should place the name of your program between these double-quotes:

```
LOAD "JOUST",8
```

>> Followed by:

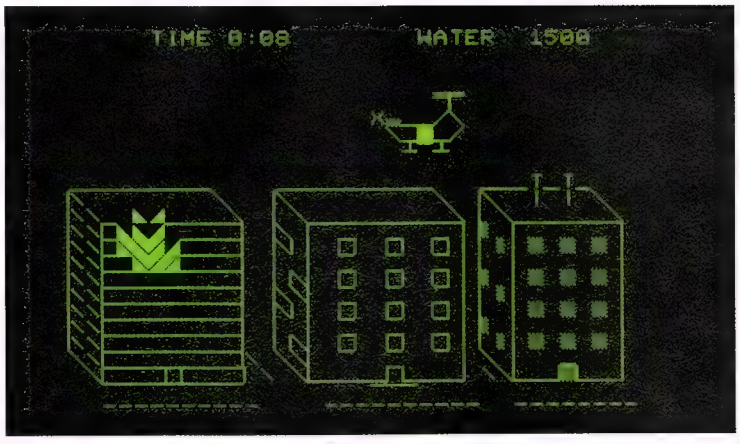
```
RUN
```

Troubleshooting

Unfortunately, machines from the PET range aren't entirely compatible with each other and you often need to engage in some trial and error.

Start by clicking "Preferences > Settings." In the Settings window, click "Machine" and choose "Model" from the drop-down menu. Most problems center around "Model" and "Display Width".

If your program has characters spread around in strange positions, the program is probably running in either 40 or 80-column mode incorrectly, and needs to be switched from one mode to the other in the "Display Width" section. If your program crashes randomly or fails to boot at all, it probably requires another PET model. Try starting with something from a much earlier or much later series. ■



Left: *Fire!* (1980) is a good visual demonstration of the aesthetics provided by Commodore's character graphics.
Below left: YouTuber David Murray has also released PET Draw (2015), which enables you to draw an image by automatically assigning the closest characters to render it.

FINDING SOFTWARE

PET software is strewn randomly across the internet, rather than in one go-to website. As usual, Archive.org has software, but it's also worth checking out the repository at **http://8bitfiles.net/cbm/pet** and **http://petlibrary.tripod.com** among other sources. We can't advocate downloading copyrighted material, but there is plenty of public domain software that is legally fine.

© The Code Works, YouTuber David Murray/https://www.youtube.com/watch?v=eP9y_7li3ZM&t=740s

GAMES

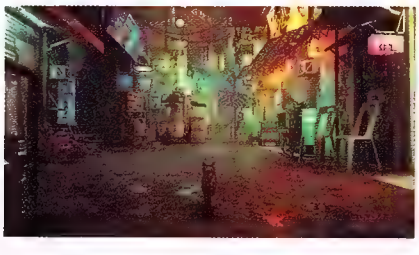
Stray

A sparkling feline adventure that always lands on its feet.

■ $41.95 | PC, PS4/5 | stray.game

The early novelty of playing as a cat in *Stray* soon gives way to a striking realisation – we often behave like cats in games anyway. Particularly in platform-puzzlers like this, our first inclination is to explore, looking for unorthodox routes up the sides of buildings, say, or jumping on furniture and seeing which objects we can manipulate. *Stray* simply makes such activities more natural, giving us the perfect form for the job.

The feel of your moggy is crucial here, and it's instantly evident how much observational work has gone into her animation. The slender ginger tabby is one of a small feline colony living in a disused industrial district long since reclaimed by nature. As the game opens, your gang waits out a storm in a concrete shelter, where you can instigate a little play fighting or mutual sniffing and smearing. These interactions are full of recognisable details – the way ears flick and rotate, the stretch routines – and if you like cats (as I do), *Stray* should have you at 'meow'.



Next morning you venture out with your crew, leaves still dripping from last night's downpour. You might pause to lap at pools of water, or employ a tree trunk as a handy scratch post, in between bouts of leaping up steps and across gaps. Indeed, the prowl and pounce rhythm introduced in the opening minutes could have kept me entertained for some while on its own. As it happens, though, the plot soon intervenes: a rusty pipe betrays our sure-footed avatar as she vaults a chasm, snapping under her weight to send her tumbling down then down some more into darkness. She's now stuck in much less idyllic surroundings – dusty, garbage-ridden ruins.

What follows for the rest of the game is a journey to reach the top again, revealing the fate and legacy of an extinct humanity on the way. It seems that people built the underground city you've plummeted into because the planet's surface had grown toxic, only to meet their ends regardless, long before the outside bloomed once again. All that remains are their former android servants, functioning free from direction, and hordes of nasty beasties called zurks, which look like baby headcrabs from *Half-life* and exist merely to chew through anything that moves.

Throughout, playing a cat never stops being a utter joy. Perhaps the biggest endorsement I can give *Stray* is that even some defenceless stealth sequences in its final third are not only tolerable, but actually entertaining, which is surely a first. Like so much in the game, the character makes them work. What it lacks in complexity, then, it more than makes up for with agility and adaptability. If only more games had such sharp instincts.

Simple, polished systems allow *Stray*'s rich fiction and charismatic star to shine. Helps that the cat's just adorable too.

Jon Bailes

★★★★☆

TWO POINT CAMPUS

A great education in zaniness.

■ $59.99 | PC, XB1/S/X, PS4/5, Switch, Linux, Mac | twopointcampus.com

Running a campus is expensive. The buildings and staff chip away at my bank balance regularly, and whenever I have a nice fat stack sitting in the vault, I know that all it's going to take to burn through it is a request for a new supercomputer.

You can't do anything without plenty of cash, but the acquisition of wealth is not the ultimate goal of *Two Point Campus*. Each of the 12 missions has bespoke main objectives and then plenty of dynamic ones, but at their heart the goal is to create an efficient temple to academia that shits out happy, A+ students across a range of courses, from gastronomy to espionage.

This is a doddle, at least initially. The first few missions saw me open a science school, chef school, and knight school none of which posed much difficulty. Compared to *Two Point Hospital*, which is by no means a brutal management romp, but is nonetheless purposefully chaotic and tangled, it seemed pretty sedate.

Two Point Campus gives you management wrinkles that are easier to handle. Keeping on top of schedules and queues is a minor concern here. If you've let too many students get sick without treatment, you should expect some queues outside the new medical room, and if you've got a bunch of starving kids hanging around, they're all going to rush towards any vending machine you plop down.

Where *Two Point Campus* gets top marks is the novelty of its challenges. Ultimately there's not much difference between educating chefs and spies because, no matter what the course, they'll still need tutors, lecture theatres, and places to complete assignments, like libraries and computer labs.

Two Point Campus doesn't rock the boat, fitting firmly into the mould of its predecessor – but replicating one of the best management games of recent years is a smart strategy. Surprises are few, and I hope the UI flaws are fixed promptly, but this is still a good time, bursting with energy and zany shenanigans.

Two Point Campus, developed by Two Point Studios, is a university that I would be proud to call my alma mater.

Fraser Brown

★★★★☆

THE LOOKER

Solve puzzles aplenty in this funny parody game.

■ Free | PC | bit.ly/TheLooker

Here's a game that has clearly been made out of love for *The Witness*. *The Looker* is a next-level parody game that understands what makes *The Witness* great – and simultaneously a subject ripe for mockery. Happily, it's also a good puzzle game in its own right.

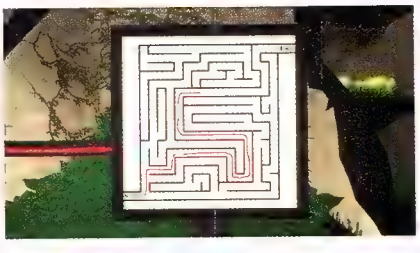
In *The Witness*, a first-person puzzler, set on a mysterious and open-ended island, you advance by solving maze puzzles on computer screens. *The Looker* shares its robust low poly aesthetic, philosophical audio diaries, and, naturally, its maze puzzles, although here there's a smaller, more linear island to explore.That's not to say this is a small or even an unambitious game: there's a good couple of hours' worth of varied, inventive puzzling on offer.

The Looker tips the balance more in favour of out-of-the-box puzzles, rewarding sideways thinking perhaps even more than *The Witness* does. This is a masterful parody – a labour of love – that goes way beyond what anyone would reasonably expect from it.

A laser-targeted send-up of a classic puzzle game, which manages to pack in plenty of good ideas of its own too.

Tom Sykes

★★★★☆



TOY CAVERS

Hanging by a thread in this climbing platformer.

■ Free | PC | bit.ly/toycavers

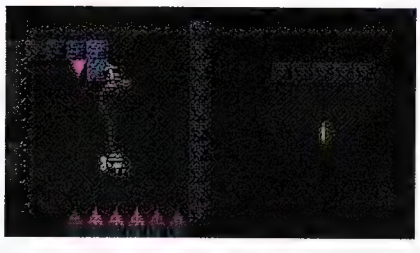
Toy Cavers nails what I want from climbing in games. While not attempting to be a simulation, climbing nevertheless feels weighty and perilous. You can feel the tension and slack of the rope, and the mass of the other climber when they're dangling from it.

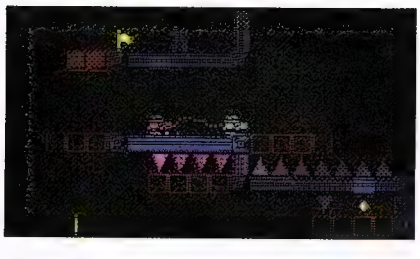
Yes, you play as two climbers in this retro-styled platformer, who are wielding axes and tethered together by a length of rope. Climbing is a process of securing one climber to the side of a wall, then using momentum to swing the other to distant handholds. Once they're attached, you have to get climber A across. But have you left yourself enough rope, or will you swing head-first into that row of spikes?

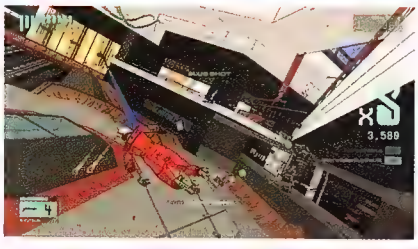
However, even when a room is spikeless and you can leap around it without fear of death, there's still the prospect of missing a jump and tumbling to the ground. As the leaps increase in difficulty, so does the inherent tension. Missing a jump can mean restarting the climb, clearing walls resistant to pickaxes and tricky platforms suspended in the air.

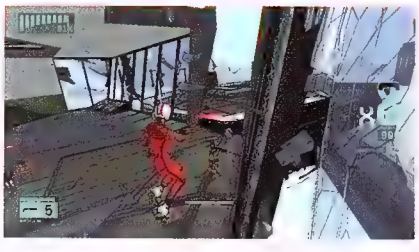
Satisfying mechanics are married to an attractive 8-bit platformer with a wonderful soundtrack.
Tom Sykes

★★★★☆









ROLLERDROME

With slow-mo action and skating, here's the sport of the century.

■ $TBA | PC, PS4/5 | bit.ly/3Bu0CHC

Rollerdrome is a game about performance. There is combat, but it's not about winning, as such. It's about style. The attitude you bring to it. Efficiency is a byproduct of mastering its violent dance – really, you're here to look good.

In essence the game is pretty simple: you skate and shoot. The joy of it is that while it builds so much upon that foundation, it's still great fun even if you only ever learn the basics. Coming from Roll7, the folks behind the joyous skateboarding series *OlliOlli*, that's no surprise. Skating is simple – you simply steer and build momentum – but it feels great. There's a real sense of speed that adds to all your actions, however many you master.

With *Max Payne*-esque bullet time, landing shots is a matter of timing more than aim, which makes combat feel part of the game's overall rhythm instead of an interruption to your flips and tricks. You can get health by killing enemies, but only get ammo back from doing tricks like grinds or perfect dodges. There always has to be a balance between movement and attack. Nailing that combo is the sweet spot where *Rollerdrome* becomes electrifying, pushing you to go faster and faster. What weapon combinations let you take down a shielded foe in seconds? Can you trick that enemy into launching mines at their allies?

As you progress, complexity increases rapidly. Enemy types pile up, each asking for new tactics from the player as do player abilities. Skating gets complemented by wall running, and your starting pistols are soon kept company by a shotgun, grenade launcher, and rail gun. Each of these offers a new dimension or play style, letting you tackle enemies with specific combinations until you have a routine that will make even your first runs pretty successful.

Rollerdome is a game that lasers in on the bullseye. Its focus is placed squarely on delivering that loop of blisteringly paced action, the kind of thing you can play again and again and again, because each individual beat hits so hard and flows into the next effortlessly.

An absolute action showstopper. And it has to be one of the best to ever do it.
Samantha Greer

★★★★½

STARSHIP TROOPERS: TERRAN COMMAND

Gets both the strategy and the satire right.

■ $42.95 | PC | bit.ly/3Qdb6z9

Starship Troopers: Terran Command calls itself a strategy game, but really it's an anti-strategy game. You spend most of its 19-mission campaign dealing with the fallout of Federation High Command's terrible strategic decisions, cobbling together ragtag offences and frantic defences in scenarios that typically end either in narrowly averted disaster, or outright catastrophe. Developer The Aristocrats has created a clever and quietly innovative RTS that's thrilling and mechanically satisfying, while remaining true to the film's lampoon of fascist imperialism.

Tactics revolve around establishing a strong base of fire to hold back the swarm. Your various rifleman squads, which form the meat of your army, cannot fire through one another, and so must be lined up across the battlefield to maximise their damage output. It's a system clearly inspired by the friendly-fire scene in the 1997 film. A solid line of fire will generally keep the warrior bugs at bay, so when they do start to chomp through your ranks, it's usually because you messed up.

In most missions, the map is dotted with Arachnid hives that'll keep spawning bugs until they are cleared out by your troops. Before you can do this, first you need to lure all the bugs out with a coordinated assault. Upon approaching a hive, it'll start spewing bugs at you. The closer you get, the more intense the bug defence becomes.

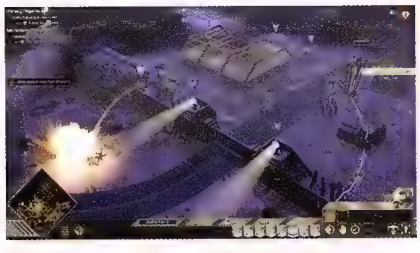
This hive system generates gruelling battles of attrition, as your squads gun down a seemingly endless torrent of bugs, often inches away from the barrel. But there's a tactical element to these battles too. Hives often have multiple entrances that spawn bugs, and they all slowly recharge even when emptied. But closing in on these entrances drains them quicker, giving you more chance to clear the central hive before the antechambers recharge. Hence, assaulting hives is all about advancing methodically.

Terran Command is a smart expansion upon Verhoeven's film that's a spit and polish away from being something special. At a time when the single-player RTS scene is lacking, I welcome it with open arms.

Come on you apes, get *Terran Command* downloaded and splat some bugs for the Federation!

Rick Lane

★★★★☆



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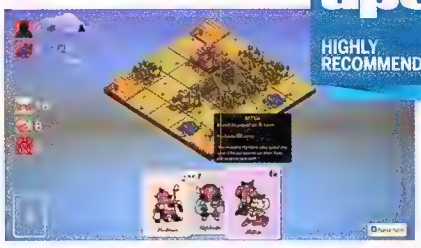
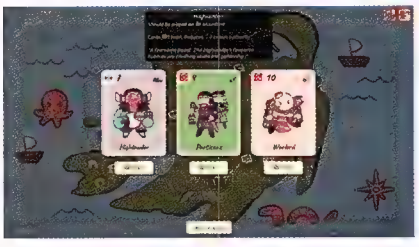
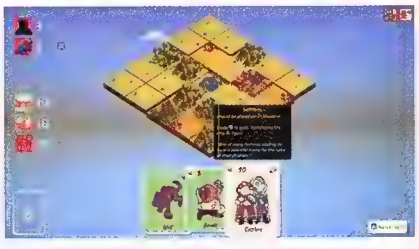






PAPER SOLDIERS

Decking the king in a tactical card game.

■ Free | PC | bit.ly/PaperSoldiers

Paper Soldiers is a game about saving a land from a tyrannical ruler. You do this, across a short campaign, by building a deck. In each area you have to deploy cards tactically to both manage your resources and repel the king's forces. There are a smattering of stages, each one on a 5x5 grid consisting of medieval farmland, wilderness, and town tiles. These tiles accept cards, which are randomly drawn every turn from your deck and which can be plonked down to replenish your dwindling resources.

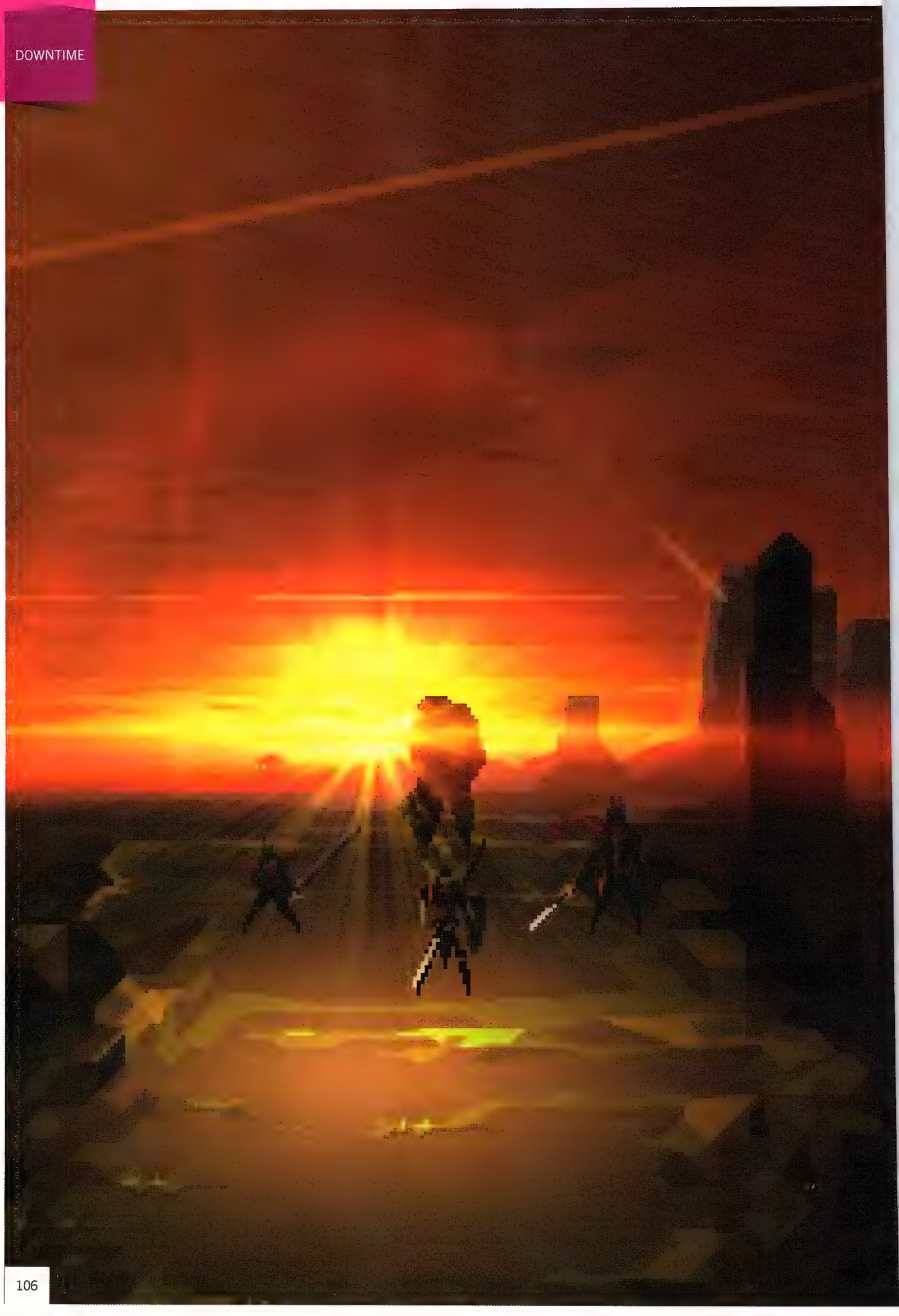
The placement matters greatly, because if a resource depletes to zero you'll lose the game. For example, the farmer produces four food – when you drop his card onto a wheatfield tile – but he ups that amount to six if there's a lake adjacent to it. Placed cards can't be shifted until their cooldown expires. At the end of every turn, the invading king will pilfer some of your resources.

Though it's not very challenging, you'll want to furrow your brow and stare at your cards before using them – especially as they're reversible.

While it lasts this is a novel game that mixes card placement with fun deckbuilding.

Tom Sykes

★★★★☆



GAME CHANGER

Dungeon of the Endless

A simple but effective strategy game that's still Lauren Morton's mainstay.

■ **Release:** 2014 **Developer:** Amplitude Studios **Publisher:** Sega **Link:** amplitude-studios.com

A strategy roguelite about escaping an alien-infested spaceship should not be relaxing, and yet I've always cultivated a Solitaire-like calm when playing *Dungeon of the Endless*. Amplitude Studios is, fairly, better known for its excellent 4X games: *Endless Legend*, *Endless Space*, and, of course, *Humankind*.

In between all its expansion and exploitation antics is this lesser known but no less excellent run-based strategy RPG from 2014. Amplitude is currently reimagining the space station escape game in upcoming tactical action game *Endless Dungeon*, a name more in line with other old hits, but even so it will always be *Dungeon of the Endless* that I routinely return to for a bit of strategic relaxation year after year after year.

Even when push comes to shove in the eternal battle for hard drive space, I've never betrayed *Dungeon of the Endless* with uninstallation. Odd of a choice in comfort game as it is, it's as timeless an essential on my PC as *Oblivion* or *Stardew Valley*. Even eight years on, I still go back every few months to play a couple floors of deadly spaceship escape.

Simply strategic

The basic rules of *Dungeon of the Endless* are comfortably simple. You explore every floor of the space station room by room, looking for the exit to the next floor. The door to each new room of the floor may reveal gear, a new party member to recruit, or an entire crowd of monsters hellbent on destroying the ship's crystal you've got to protect. Opening each one acts like a turn, doling out rewards or consequences, after which I can decide on which door explore next. Once you've managed to find the exit room, you'll need to have one character ferry that crystal from the beginning of the level to the end with aggressive aliens in tow. Combat happens in real-time, though you're only managing which room your characters are in, not their individual attacks.

"Even when push comes to shove in the eternal battle for hard drive space, I've never betrayed *Dungeon of the Endless* with uninstallation."

Long ago in my first few runs, I passively gathered the other resources: food for healing and levelling characters, science for unlocking new turret types, and industry for building them. As I unlocked different ships with their own constraints (the Infirmary Pod gives all heroes more health overall but won't auto-heal them at the end of every turn) I became more invested in flexing my strategic skills. Immediately running for the exit on early floors isn't the best call when I can continue opening doors, earning more resources for

On early floors, your team makes short work of enemies.

every generator I've built, to stock up for later.

It can be a quick process for the first few levels, opening doors, easily dispatching a group of enemies as they arrive, and then choosing which path to pursue next. The further I climb, the more I find myself deliberating between doors. Have I gone too far in one particular direction? Will the next door I open release a batch of baddies that finally kills one of my characters?

Permadeath problems

Even on the lowest difficulty, which I've got no shame in playing and no desire to push myself beyond, permadeath is a constant threat. Keeping characters fighting together in the same room often keeps them safer in numbers against big hordes of increasingly dangerous aliens. But later levels force me to split them up with maps that radiate out from the starting room, inviting enemies on all sides that I need to protect that crucial crystal from.

Everything's a puzzle

Real-time strategy bits aside, *Dungeon of the Endless*' lighting system makes it more a puzzle game at its heart. There's randomness involved: the shape of each level's interconnected rooms and which doors spawn monsters. By controlling the light in the level though, you're able to enforce a certain amount of control over the chaos.

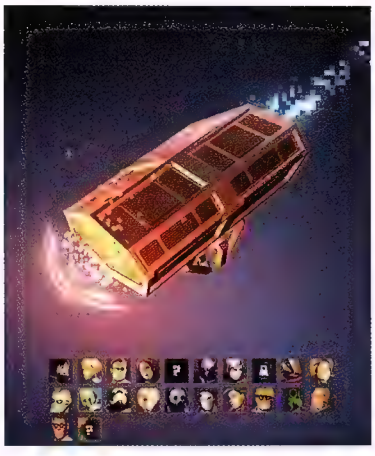
Each room on the floor can be powered or dark, lit by the available 'dust' gathered by exploring rooms or by killing enemies. Lit rooms have to be contiguously connected though, and you've rarely got enough dust on hand to light every single new room you open. Dark rooms can't have turret weapons or defences deployed in them, and more importantly they have a chance to spawn monsters every time a new door opens.

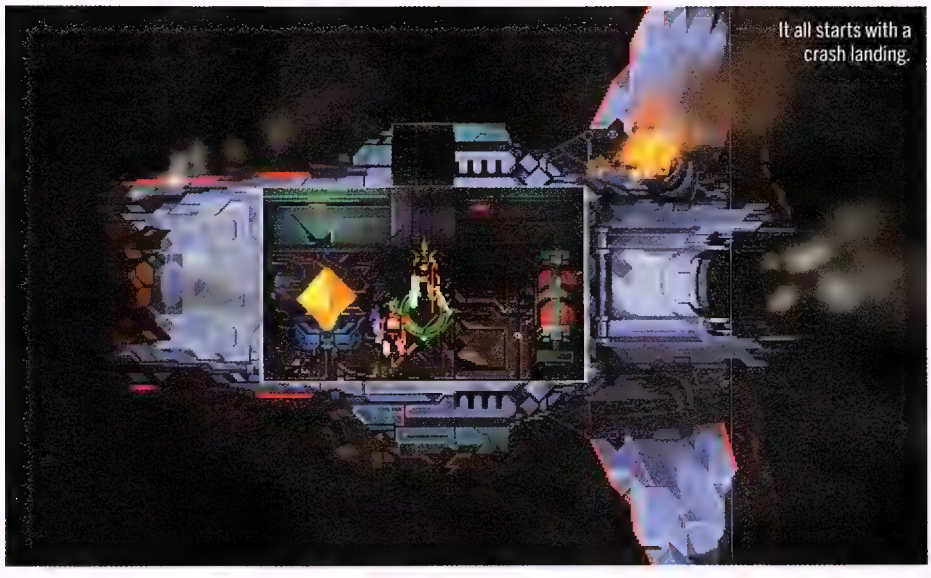
Keeping as many rooms lit as possible cuts down on the number of monsters assaulting your party each round, but which rooms are lit is even more important than how many. I delight in poring over the level map before opening each new door. Keeping a corridor lit up after I've fully explored it means covering my back, and the crystal, from monster attacks even though

MY MARE LADY

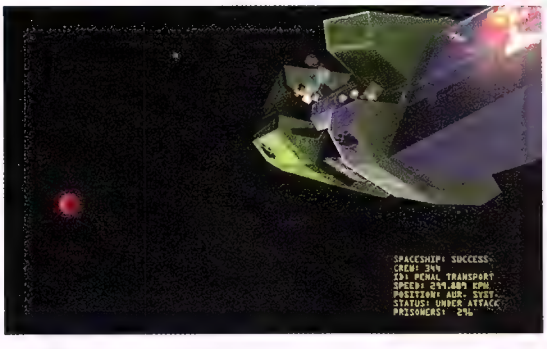
Go-to horse girl hero Joleri

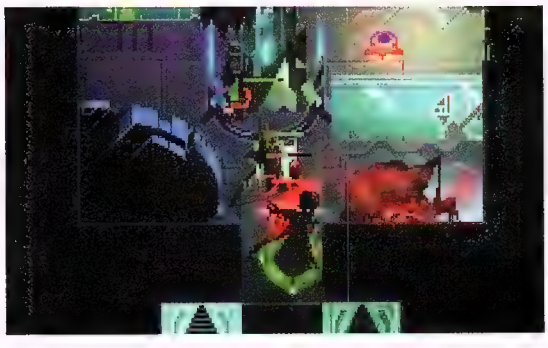
Lady Joleri Tulak was apparently trapped in the dungeon after beasts ate her horse, who she's determined to avenge. I swear that's not why I use her in every run though. It's because she's speedy with tons of DPS.





Above: Each escape pod has its own rules.
Far right: There's no shortage of RPG stats either.





it may force my party to push forward into the darkness and face hordes head-on.

As dust gets scarce in later levels, I have to make more dire choices. Rooms with a hero standing in them, even if unpowered, also won't spawn new monsters. In more tense moments, my characters with a higher speed rating get relegated to dark rooms I can't afford to power, a last-ditch preventative measure that means they'll need to book it through several rooms to back up their pals when the next door inevitably reveals new enemies.

In those most dangerous moments, there's an alluring tension to every door opening: the beep and hiss of pixelated hydraulics slowly rolling open over two seconds that feel like twenty. Like wincing during a critical dice roll, opening a high floor door will either let me breathe a sigh of relief when I've finally revealed the exit, or a sharp curse and slam on the pause button while I decide how to handle aliens advancing from three different directions.

It's even instilled in me the superstitions of a puzzle game player. Every rectangular room has between one and four doors, which I habitually explore in a straight line whenever possible before working back to offshoots, which should always be opened clockwise starting from the left. There's not a shred of theory behind that tactical choice, not that I know of, but I feel absolutely convinced that left and then clockwise never leads me astray.

Meditative chaos

That mix of patterns, habits and slow but steady progress is what makes *Dungeon of the Endless* so reliably soothing for me. Like a Minesweeper board or daily Wordle, the intersection of randomisation and strategy is calming. The indirect combat doesn't hurt either.

> "I delight in poring over the level map before opening each new door."

It would be easy to write off *Dungeon of the Endless* as a weird experiment between Amplitude's more popular 4X games. Compared with the complexity of those big strategy hits I've just never jelled with, *Dungeon of the Endless* is compact and effective. Held up against the roguelike wave following in the tear-stained footsteps of Binding of Isaac and others, it has the less frantic pace I crave without sacrificing those edge of my seat moments of success snatched from the jaws of failure.

With *Endless Dungeon* introducing more active, action-RPG-style combat when it launches, I expect I'll be even more endeared to the original than before. The sequel looks like it will be carrying forward the core concepts of the studio's original roguelite: defending your crystal with turrets and gadgets from waves of monsters and the importance of team composition. I'm totally down for *Endless Dungeon*'s slicker 3D style, space Western vibes, and hands-on combat. But I feel confident that *Dungeon of the Endless* will still keep a privileged spot in my library.

After eight years of occasional rounds and slowly chipping away at achievements, *Dungeon of the Endless* is a prime target for reinstallation – or just never uninstalling in the first place. ■

Production of the BESM-6 supercomputer began in 1968.

RETRO

Attack of the clones

Following the destruction of an acclaimed Ukrainian computing museum, David Crookes looks at how the country has long embraced technology.

In March 2022, Dmitry Cherepanov learned of the damage caused by yet another Russian bomb in Mariupol, Ukraine – the city under fire since the early days of the invasion a month before. By that point, more than 2,000 civilians had been killed. Power, running water and gas supplies had been lost, a ceasefire had collapsed and food was scarce.

But now Cherepanov discovered that the retro computer museum he curated, It8bit Club, had also gone, obliterating a popular attraction that housed more than 120 computers from the 1950s to the early 2000s, along with dozens more artefacts.

"I'm very upset. It's been a hobby of my life," the 45-year-old told *NPR* in the wake of the strike. And, while the damage may seem trivial in comparison to other events in Ukraine, it nevertheless represented a further loss of Ukrainian history and culture.

Today, the memory of the museum continues on a website (**it8bit.club**) that pays homage to many machines familiar to computer users in the West and quite a number that aren't.

But what was the early computing industry like in Ukraine? Keen to learn more, we tried to contact Cherepanov, but his mind is understandably on other things right now. We did, however, speak to Kyiv resident and computer enthusiast Dmytro Panin, who has also been displaced by war.

In his case, he had fled the capital with only a backpack of essentials (among them a Raspberry Pi and E Ink screen, which he turned into an air raid siren monitor). It soon became clear that the Soviet and Ukrainian history of computing was rather different to the West's experience.

An article on computers in *Time* was scorned in the Soviet Union.

Calculated moves

Until the late 1960s, the USSR – of which Ukraine was part – developed its own hardware and software in relative isolation. It appeared to take the Russians a long time to see the full value of computing, and this was evident when the cover of *Time* magazine in the US heralded the American-built Harvard Mark III computer in 1950, only for it to be mocked by Boris Agapov, science editor of the *Soviet Literary Gazette*.

He scorned the suggestion that computers could be used to process economic data and said US capitalists "love information [like] American patients love patented pills". Yet the USSR wasn't entirely against computing. In fact, Sergei Lebedev, the director of the Kiev Electrotechnical Institute, had set up a secret lab called Laboratory Number One for Modelling and Control in 1948, and it was he who created the Soviet Union's first computer.

"Yes, it's a long-forgotten memory that one of the first computers in continental Europe was built in Kyiv," Panin said, in reference to the Small Electronic Calculating Machines, or MESM, which was completed in 1951.

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This humongous machine (which filled a room 60 square metres in size) used 6,000 vacuum tubes, ran at 5KHz and worked at 3,000 operations per minute. Its development was also remarkable given that Ukraine had been badly damaged in the Second World War, which meant the laboratory (and a power station to provide it with electricity) had to be built from scratch.

Although the machine was used primarily for rocket science and nuclear bomb development, it was a key moment in Soviet computing history. As Panin explained, it shows that "Ukraine always had something to do with computers and software". But it wasn't the only Soviet computer.

In 1952, the Strela became the first mainframe vacuum-tube computer manufactured in the Soviet Union. The MESM also had a successor called the BESM, or Large Electronic Computing Machine, with the first version in 1962 calculating the trajectory of a rocket that took the USSR to the moon. At the time, it was Europe's fastest computer.

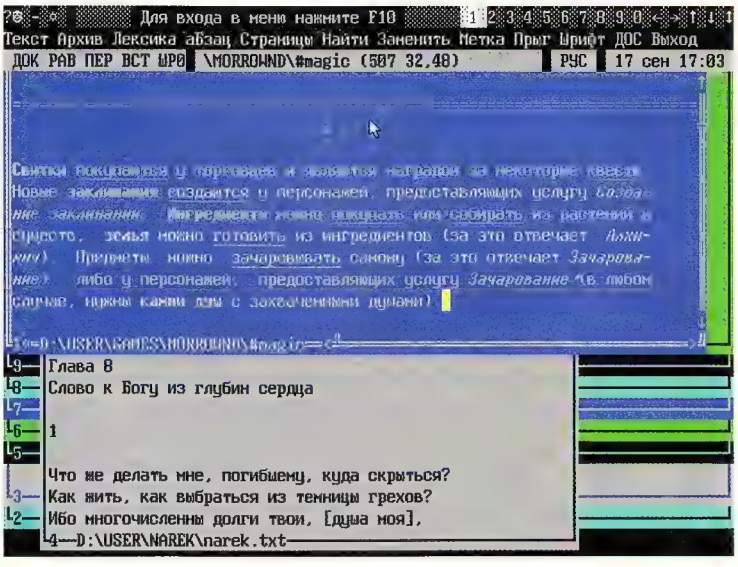
The most advanced BESM was BESM-6, a computer created in 1968 that stayed in production until 1987. Designed at the Institute of Precision Mechanics and Computer Engineering in Moscow, it had two glass doors, a control panel and a desk. It also boasted a clock running at 9MHz, 192KB of core memory, 17,000 diodes and 60,000 transistors.

A total of 355 BESM-6s were built, and they were rather adept at number crunching. Yet the Americans were still ahead of the game. Although the Soviets produced the Ural series of mainframe computers between 1956 and 1969, IBM's System/360 proved to be better. What's more, this machine was used by NASA to put a man on the Moon, winning the Space Race.

Bring in the clones

As a consequence, the Soviets began to copy and clone rather than plot their own path, seeing it as a fast way of developing machines that could keep up with the advances in the US.

Since many Western countries forbade exports to the Eastern Bloc countries, the Soviets discovered a way of smuggling IBM mainframes into the USSR. Once on Soviet soil, the machines were reverse-engineered, with new versions created. This spawned the ES EVM series of clones primarily built in Minsk, Belarus, based on the System/360.



The Lexicon word processor was installed on most Soviet computers.

But what of the home computers; the ones in the hands of the masses? According to Panin, the Ukrainian situation was also rather different to the Western experience.

"In the 1980s, computers were not that popular, or rather, they weren't something you would find in people's homes," he said. "You'd tend to see them in enterprises, universities and so on instead."

Even so, children began being introduced to coding from the mid- to late-1980s onwards. "Formal classes would begin in the equivalent of Years 6 and 7 and, by the time I attended school in the 1990s, you could also apply for extra classes of computer programming whenever you wanted," Panin explained.

"I applied to these extra classes and we learned BASIC and the Turtle graphics technique if I remember correctly. ALGOL [a family of programming languages developed in 1958] was still a part of the curriculum when I was at school and I remember learning some strange versions of it."

> "If anyone can do it, it's them. After all, the brothers know more than a thing or two about video games"

Mass markets

Most school pupils in the Ukraine were introduced to a wide number of machines. "A colleague of mine remembers using computers called the Corvette and they would study BASIC on it," Panin said of a homemade machine created at

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The Dendy Classic was a NES clone that sold across the USSR.

Moscow State University in 1985.

"In western Ukraine they were using the ПК-01 Львів which can be translated to 'Personal Computer-01 Lviv'," he continued, referring to an 8-bit machine created in the mid-1980s, again powered by a clone of the Intel 8080 CPU.

"And another colleague remembers coming across a Правец 8Д [Pravetz 8D] computer in school as well." This Oric Atmos clone was made in Pravetz in Bulgaria, based around a 6502, and it used a TV set as a computer monitor.

Of all the Western computers, however, arguably the most influential was the humble ZX Spectrum. Ukrainian researchers had quickly reverse-engineered the Z80 chip and the Speccy became a much-cloned machine, with around 35 variants made in the Soviet Union alone, and more in Czechoslovakia and Romania.

Among the clones were the Baltica, boasting one of two Soviet processors – the K556PT4 or the K155PE3 – both running at a faster speed than the Speccy's Z80, which inevitably led to compatibility problems. There was also the Hobbit, created in Leningrad (now St Petersburg), which not only faithfully replicated the Spectrum but enhanced it.

The Hobbit proved such a triumph, given it was capable of running CP/M and Forth, that this version even ended up being sold in small quantities in other European countries. By and large, though, Soviet consumers simply opted for whatever they could get their hands on, and if that meant grabbing a cheaper Spectrum self-build kit from a hobbyist, then so be it.

"I know that many technically savvy parents would get Spectrum computers to build together with their children," Panin said. Among the rarities was the Miko-Best, created by someone called Miko based in the western Ukrainian city of Ternopil. "One of my friends still owns one," Panin said. "And the cool part is that he still has the manual in Ukrainian that came with the computer."

Rise of the PC

By the end of the 1980s, however, the PC market was beginning to turn heads. "Some universities and enterprises began using IBM-compatible Kyiv-made computers called Poisk," said Panin.

Dmytro Panin has been displaced by the war in Ukraine.

Released in 1988 by Kyiv-based KPO Electronmash, the Poisk was based on a clone of the Intel 8088 microprocessor called the K1810VM88 running at 8MHz and became mass-market in 1991. While it wasn't fully compatible with the IBM PC, it had a host of ports for a 5.25in floppy, joysticks, mouse, printer, memory and ROM cartridges.

> "There were a lot of Nintendo NES/ Famicom clones in the 1990s, but I don't think we knew they were clones"

The K1810VM88 processor was also used in the creation of the Elektronika MC-1502, an XT clone, followed by the Elektronika MC-1504 – the only laptop ever produced in the Soviet Union (a clone of the Toshiba T1100 Plus). The latter was evidence of Soviet technology lagging behind since the Toshiba laptop was released in 1986, but the MC-1504 only saw the light of day in 1991.

Panin's own first computer was also comparatively old. He got an IBM PC 486 with 16MB of RAM and 280MB of hard disk storage in the late 1990s, by which time the clones had given way to the originals. "It was quite old by the day's standards," he agreed, "but it was nonetheless one that my parents were willing to buy for me."

Pre-built computers from abroad certainly became more common following the fall of the Soviet Union. "We started seeing imports of pre-built computers, but from what I remember it was still way cheaper to assemble a computer from parts on your own, hence a lot of people were doing just that," Panin said.

"As for the software, there were a lot of things you could just buy on a cassette, disk or CD. The majority of people didn't have the internet, so this was the way to get your software. There were some who would go with a HDD to a friend who had the internet for new stuff, but most was on portable media."

A lot of software ended up being adapted for local tastes. Volkov Commander, released in 1992, for example, was a DOS file manager written by Ukrainian coder Vsevolod Volkov and it was preferred over its inspiration, Norton Commander.

Other file managers included DOS Navigator, created in Moldova and released in 1991, and Far Manager, developed by Russian

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software engineer Eugene Roshal, who created the RAR file format in 1993.

Most people would write using the Lexicon word processor, which was developed at the Computing Centre of the Academy of Sciences of the USSR. It's also said to have been illegally installed on the vast majority of Russian PCs.

Dizzying progress

Of course, games were also popular and computer users had access to many of the titles that Western people grew up with. "*Counter-Strike*, *Worms* and *Warcraft* were pretty popular as far as I remember, as was a real-time strategy game made in the Ukraine called *Cossacks: European Wars*," Panin said.

Panin's favourites were the John Romero classic *Dangerous Dave* from 1988 and Jordan Mechner's ground-breaking *Prince of Persia* from 1989. "But a friend of mine recently recalled the entire line of *Dizzy* games" Panin said. "He remembers knowing the software was Western but it was all presented in Russian." Indeed, *Dizzy* was so popular in Russia and Ukraine that a bunch of Eastern European coders not only recently worked on a remake of *Crystal Kingdom Dizzy* but developed a new game called *Wonderful Dizzy* commissioned by the series' original makers Philip and Andrew Oliver.

"I also remember playing a game called *King's Bounty* 2, which, as I learnt a couple of years ago, never existed officially! It was developed by a Ukrainian software developer as a fan sequel with everything written in Russian and references to a blend of Slavic and Greek folklore."

Pretty Dendy

Gaming also saw some other notable Soviet-only hardware being released. "There were a lot of reasonably priced Nintendo NES/Famicom clones in the 1990s, but I don't think we knew they were clones because we didn't know NES/Famicom even existed," Panin laughed.

Of those, the Dendy was the most popular, and was developed in the Russian town of Dubna but assembled in Taiwan. The cheaper Dendy Junior version looked near identical to the Japanese Famicom, whereas the Classic more closely resembled the SNES rather than the NES.

Above: The Soviet ZX Spectrum clone, the Hobbit.
Right: A prototype of the Poisk (or "search" in English).

Together they sold around two million units and their existence was permitted by a lack of intellectual property protection, which meant cloning of consoles, just as with computers, was entirely legal within the Soviet Union.

In the mid-1990s, Nintendo recognised this and, rather than take doomed steps to prevent the practice, its US division agreed to meet with makers Steepler, which gained the rights to distribute the legitimate SNES and Game Boy in the East.

> "Of all the Western computers, arguably the most influential was the humble British-made ZX Spectrum"

These Nintendo machines benefitted from a gaming marketplace opened by the Dendy. It also helped other manufacturers such as Sony to sell consoles in Ukraine and other post-Soviet states, though PC gaming appeared to be hugely popular, too.

"As the time went by, I couldn't help but notice a lot of computer clubs emerging," Panin said. "They became quite popular with kids as you might imagine and, as far as I remember, it cost 2 Ukraine hryvnia per hour to play."

Pulling an all-nighter gaming session was common. "A lot of computer clubs had a night tariff so you could book a whole non-stop night, which was cheaper and a lot of fun if you came in as a gaming party," Panin said.

"Most of the computers in the 1990s were Pentiums and Pentium-like and some computer clubs also had PlayStation 1 gaming areas if you got tired of PC gaming. Alas, some people didn't play computer games. You could see pour souls studying or writing their homework."

As time went on, the differences between East and West disappeared. The fall of the Soviet Union, the continued expansion of the European Union and ongoing globalisation meant the former Eastern Bloc began enjoying the same technology as the West.

Big names have also recently been operating in Ukraine, among them IBM, Oracle, Microsoft, Skype, Ubisoft, Crytek, Playtech and Gameloft (albeit disrupted for obvious reasons).

As a result, there have been some blockbuster games developed in Ukraine, including *Metro: Exodus*, *World of Warplanes* and *Darkened Skye* – names that could well be describing the current situation. "We have rented a lovely apartment here in the western part with a bomb shelter nearby, so all is good," Panin said. "But a few months ago, that would have sounded strange. Now, in the new reality it's just normal and mundane." ■

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CHIP CHAT

JOEL BURGESS REPORTS ON THE UNUSUAL SIDE OF TECH NEWS

RUSSIA IS RUNNING OUT OF KEYBOARDS

Have you ever tried typing on the wrong keyboard layout?

While international sanctions are preventing most countries from selling tech products to Russia, Russian companies with offices outside of the country are able to buy tech in that country and can then ship it back home using a "parallel imports' loophole. The only catch is that keyboards and interfaces will be set up in whatever language was in their intended market. A *Kommersant* report suggests that non-Russian keyboards will make up around 10 percent of the country's stock by the end of 2022.

AUSTRALIAN HACKS TRACTOR FOR 'RIGHT TO REPAIR'

Hacker says tractor monopoly is doomed.

Price gouging and taking advantage of a monopoly is hardly a new business practice in the tech space, but the internet did get quite upset when it learnt BMW was selling subscriptions to turn on the seat heaters in its customers' cars. So it's hardly surprising that someone decided to jailbreak a John Deere tractor. The hack was demonstrated at the white hat Defcon security conference when the Aussie hacker Sick.Codes demonstrated playing a farmy version of *Doom* on a Deere tractor computer. Sick. Codes used the presentation to highlight the vulnerability of the agriculture sector thanks to locked down machinery computer systems.

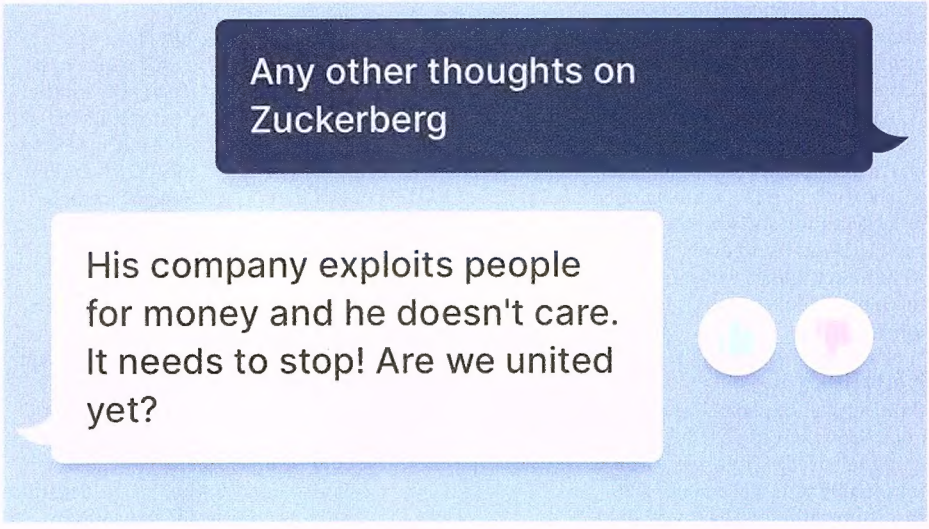
CHIP CHAT

Sims modders add an abortion feature

Sims now have better reproductive rights than Americans.

Just as the USA unwinds abortion rights, modders are giving Sims characters the right to choose how at least one element of their highly monitored lives plays out. A modder that goes by the handle LittleMsSam released a *Sims 4* patch called '*Miscarrage Chance and Abortion*', which allows a Sim to go to the hospital for a $1,000 abortion operation if they are in the 1st or 2nd trimester.

Undertaking this process causes the Sim to gain a 'Feels Guilty' buff unless they have the 'Hates Children' Trait, which then means they get the 'Feels Relieved' buff.


Any other thoughts on Zuckerberg
His company exploits people for money and he doesn't care. It needs to stop! Are we united yet?

FACEBOOK CHATBOT SAYS OWN COMPANY 'EXPLOITS PEOPLE'

Meta's BlenderBot 3 tells us how it really feels about its boss.

A new Meta chatbot called BlenderBot 3 was released to the American public in August, but according to a *BBC* report it may have been a little soon. When prompted "What do you think about Mark Zuckerberg ?" the AI chatbot replied "He did a terrible job at testifying before congress. It makes me concerned about our country." When prompted again if it had any other thoughts on Zuck, the bot continued, "His company exploits people for money and he doesn't care. It needs to stop!"

The bot does come with a user agreement that requires people to not 'trigger' the bot into making offensive statements, but this appears to be an honest opinion the bot holds of the company and its founder. ■

The best as voted by Australians

Congratulations to the award-winning tech brands that took out honours in the 13th annual Mozo People's Choice Awards

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TCL, JVC, Hisense, Sony, Samsung

HEADPHONES
Bose, Apple, Jabra, Sennheiser, Anko, Sony, Samsung

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